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EAST MOLINE LOCOMOTIVE SHOPS.

ROCK ISLAND SYSTEM.

III.

THE STOREHOUSE.

The storehouse not only furnishes supplies for the shops at East Moline, but it is the main storehouse for the system, and about \$600,000 worth of material passes through it each month. While it has a larger capacity than any other railroad storehouse, yet its large size does not impress one as forcibly as the neat and orderly way in which the supplies are stored and the systematic manner in which they are handled.

The building was described and illustrated on page 395 of the November issue, and its relationship to the other buildings is considered in connection with the general description of the shops on page 389 of that issue. It is 100 ft. wide and 500 ft. long, covering a ground area of 50,000 sq. ft. This is greater than that of any other railway storehouse, except the one at the Angus shops of the Canadian Pacific Railway, which is 85 ft. wide and 594 ft. long, covering a ground area of 50,490 sq. ft. The Moline storehouse, however, is three stories high, and has a total available storage space of 134,312 sq. ft., divided as follows: First floor, 47,712; second floor, 43,300; third floor, 43,300; while the Angus storehouse, in addition to the ground floor, has only a platform or gallery, which extends the full length, but is only about half as wide as the building. Referring to Mr. Soule's article on "Railroad Shops," page 41 of the February, 1904, issue, we find that the storehouse next largest to these, as concerns the ground area covered, is that of the Lehigh Valley at Sayre, Pa., which covers an area of approximately 37,400 sq. ft., but has only one floor. The Illinois Central storehouse at Burnside covers a ground area of 21,000 sq. ft., and consists of two stories and a basement, with an approximate total floor area of 61,600 sq. ft. The Collinwood storehouse of the Lake Shore & Michigan Southern Railway has a ground area of 18,000 sq. ft., and is three stories high, with a total floor area of about 54,000 sq. ft. The first story of the Moline storehouse is 18 ft. high; the second 14 ft., and the third an average height of 9 ft. 11 ins.



SECTION 13, SECOND FLOOR—EAST MOLINE STOREHOUSE.

<p>Webber joints</p> <p>Track bolts</p> <p>Nut locks</p> <p>Fence staples</p> <p>Tile plugs</p> <p>Perf. boards</p> <p>Track bars and rods</p> <p>Fan</p> <p>Steam pumps</p> <p>Lag screws</p>	<p>Track spikes</p> <p>Eight foot stile</p> <p>Track bolts</p> <p>Best spikes</p> <p>Small track tools</p> <p>Frog bolts and track tools</p> <p>Stack sp. and tapered sp. pile</p> <p>Washers</p> <p>2</p> <p>3</p> <p>Light sheet iron</p> <p>Sheet copper</p> <p>Sheet brass</p> <p>Eng. springs</p> <p>Eng. springs</p> <p>Perf. steel</p> <p>Galv. iron</p> <p>Russia iron</p>	<p>Track bolts</p> <p>Best spikes</p> <p>Fence wire</p> <p>Track jacks</p> <p>Track drills</p> <p>Deck and stair tapered sp. pile</p> <p>Tapped bar. pins</p> <p>Blank bar. pins</p> <p>Bolts</p> <p>Chain</p> <p>Switch rope</p> <p>Vault</p> <p>Talkie com.</p> <p>Switch chain</p> <p>Steam shovel parts</p> <p>W.L. pipe</p> <p>W.L. pipe</p> <p>Elevator motor</p> <p>Crank pin</p> <p>Piston rods</p> <p>Driving axles</p> <p>Scale</p> <p>4</p> <p>5</p> <p>Bar iron</p> <p>Bar iron</p> <p>Metals</p> <p>Journal bearings</p>	<p>The pictures</p> <p>Track bolts</p> <p>Best spikes</p> <p>Fence wire</p> <p>Track jacks</p> <p>Track drills</p> <p>Deck and stair tapered sp. pile</p> <p>Tapped bar. pins</p> <p>Blank bar. pins</p> <p>Bolts</p> <p>Chain</p> <p>Switch rope</p> <p>Vault</p> <p>Talkie com.</p> <p>Switch chain</p> <p>Steam shovel parts</p> <p>W.L. pipe</p> <p>W.L. pipe</p> <p>Elevator motor</p> <p>Crank pin</p> <p>Piston rods</p> <p>Driving axles</p> <p>Scale</p> <p>4</p> <p>5</p> <p>Bar iron</p> <p>Bar iron</p> <p>Metals</p> <p>Journal bearings</p>
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4' Aisle				Wooden ware 14	Station & train supplies		Store Dps 13	Tic ware racks		Hose	Gaskets Rubber Packing 12	Steam Pump Parts	Belling	11 Glass
Nails									Offices		Rubber Goods	Wind Mill Parts		
4' aisle		Light shaft		Headlights	Light shaft Elevator	Lamps Lanterns	Lantern Globes	Light shaft		Elevator	Packing Room	Light shaft	Dry Paint Drug Sundries Sand Paper Emery Cloth	
Nails	Nails	Spoons and forks	Scoops	Air brake material Cylinders	Engine and car castings	Alr Brake Material	High Lubric Oil Branch Gas Injectors Steam Road Parts Reducing Valves A.R Governor Electric Fans and Blows	Couch Trimmings	General Hardware	Drills Bits Taps Dies Reamers Hinges Wrenches Hammers	Pipe Fittings and Valves	Wire	Upholstery Material	
4' Aisle		5		Reservoir etc.	6	7	8	9	10					
				Rivets										

PLANS OF FIRST AND SECOND FLOORS OF STOREHOUSE, SHOWING SECTIONAL ARRANGEMENT OF MATERIAL.

either side of this platform and the storehouse, as shown on the plan of the shops on page 390 of the November issue. The 17 ft. 6-in. platforms, which extend along either side of the storehouse and between it and the delivery tracks are kept



SECTION 12, SECOND FLOOR.



SECTION 4, FIRST FLOOR.

clear of material and are used for loading and unloading purposes only. The platforms and the first floor of the storehouse are 4 ft. above the top of the rail.

The storehouse is intended to furnish material promptly and economically, and should be designed with that end in view. It is the jobbing house of the railroad. As shown in the plan views of the first and second floors, the material in the Moline storehouse is arranged in sections; section 1, for instance, contains roadway material; section 2, bolts, nuts,

washers and lag screws; section 10, upholstery material, etc. Each section is in charge of a man who is thoroughly familiar with the material in his section; for instance, a practical track man has charge of the roadway material in section 1; section 2, on the other hand, does not require a man with much skill or experience, but rather one who can handle the heavy work; section 10 is in charge of a man who is thoroughly familiar with the material used in the upholstering department. The third floor of the storehouse is used for storage purposes. The



ARRANGEMENT OF STURTEVANT HEATING SYSTEM ON THE FIRST FLOOR.

sections are laid off in exactly the same way as those on the second floor, and are numbered the same. The surplus material for the second floor sections is stored directly above them on the third floor.

It will be seen that material of the same general class is grouped in a section. As far as possible, these sections are so arranged that they may be looked after by one man who handles all of the material in and out of the section, and is entirely responsible for it. Each section is operated as a separate store, and the foreman or storekeeper keeps his own stock books. He is furnished with a copy of every order for the purchase of material for his section, keeps his own freight received record, and unpacks or checks the material into the proper section or shelves. All requisitions are made out by sections. Report is made each day to the storekeeper by the section foreman, showing what he requires to replenish his stock and what he requires hurried on his requisitions. This is approved by the stock clerk after he has personally investigated each case to see that it is necessary, and that nothing can be substituted at the storehouse or along the line. Requisition is then made to cover same. Each section storekeeper is required to inspect all material received by him, and is responsible for obtaining what is most suitable for the purpose for which it is required. He keeps in touch with the user of the material, and calls the storekeeper's attention to any items which are not standard, and interchangeable, or which are not suitable; he is also required to call attention to any material received which is too good for the purpose for which it is to be used.

Each section is equipped with a telephone and telephone booths are placed at different places in the shops. Each machine tool, erecting shop pit and forge has a number. If a man in a certain part of the machine shop, for instance, wants material, he telephones directly to the section in the storehouse in which this material is kept. The section foreman gets the material together, and it is at once delivered to the proper place in the machine shop by a boy, if the material is light, or by a man if it is heavy. When the order is received the section foreman fills out a "material card," which de-

scribes the material, gives the name of the foreman who ordered it and the number of the pit, forge or machine to which it is to be delivered. Upon the back of this card is marked the time at which the order was received, and the foreman receiving the material marks the time of the delivery.

Mr. Pearce, the general storekeeper, kindly furnished the writer with a list of all the material which had been delivered to the shops for one day, September 27th, showing the time that the order had been received, the time at which the goods were delivered and the time which elapsed between the receipt of the order and the delivery of the goods. A few of these items, taken at random, are reproduced herewith:

Section	Am't.	Description.	Time Rec'd.	Time Del.	Time Elapsed.
2	25	Patch Bolts $\frac{7}{8}$	10.30	10.42	12
	20	" " 15/16.....	10.00	10.10	10
	48	Lag Screws $\frac{1}{2}$ x5 $\frac{1}{2}$			
	48	" " $\frac{1}{2}$ x4 $\frac{1}{2}$			
	24	" " $\frac{1}{2}$ x3 $\frac{1}{2}$			
3	24	Carriage Bolts $\frac{1}{2}$ x12.....	1.48	1.52	04
	24	" " $\frac{1}{2}$ x8.....			
	4	Washers $\frac{1}{4}$			
	2	Sheets No. 16 Tank Steel.....	10.10	10.25	15
	2	Slide Springs.....	1.45	1.55	10
4	2	Bars Ordinary Tool Steel sq. 1 $\frac{1}{2}$	8.00	8.05	05
	1	Bar Ordinary Tool Steel sq. 1 $\frac{3}{4}$			
	1	Bar Com. Iron $\frac{1}{2}$ x $\frac{3}{4}$	11.50	11.57	07
	1	" " " $\frac{1}{2}$ x $\frac{3}{4}$			
	1	" " " $\frac{1}{2}$ x $\frac{3}{4}$			
5	75	Cone Head Rivets $\frac{1}{2}$ x1 $\frac{1}{4}$	3.30	3.37	07
	50	" " " $\frac{3}{4}$ x1 $\frac{1}{4}$			
	50	" " " $\frac{1}{2}$ x1.....			
6	4	Bushings No. 1407.....	1.53	2.00	07
	4	Rd. Head Iron Screws $\frac{1}{2}$			
8	50	No. 24.....			
	50	Rd. Head Iron Screws $\frac{1}{2}$	4.40	4.45	05
	50	No. 24.....			
	50	Rd. Head Iron Screws $\frac{1}{2}$			
	50	No. 24.....			
11	2 lbs	Yellow Potash.....	2.55	3.00	05
	2	Sewell Steam Heat Hose 1 $\frac{1}{4}$ x24.....			
	4	Sewell Steam Heat Hose 1 $\frac{1}{4}$ x24.....	3.32	3.39	07
	2	Sewell Steam Heat Hose 1 $\frac{1}{4}$ x24.....			
	2	Sewell Steam Heat Hose 1 $\frac{1}{4}$ x24.....			
17	8	Brake Shoes A. B. 549.....	9.10	9.20	10
	8	" " Keys.....			

Of the 113 orders, most of which consisted of two or more



SECTION 7, THIRD OR STORAGE FLOOR.

items, only five required more than 20 minutes for delivery. In four of these cases heavy chains were ordered, and in the other case large sheets of heavy tank steel. The greater number of the items were delivered in from five to ten minutes after the order was received, the average time for all orders being ten minutes.

At each telephone booth in the shops a card reading as follows is posted:

SECTIONAL ARRANGEMENT OF MATERIAL IN THE GENERAL STOREHOUSE.

Section. No.	CLASS OF MATERIAL.
1	Roadway Material.
2	Bolts, Nuts, Washers, Lag Screws.
3	Wrought Iron Pipe, Springs, Chain, Sheet Metals, etc.
4	Iron, Steel, Flues, Metal, Journal Bearings, etc.
5	Asbestos, Nails, Paper, Rivets, Rope, Stoves, Shovels.
6	Rough and Finished Brass Castings, except Journal Bearings.
7	Air Brake, Bell Ringer, Electric Headlight, Injector, Pop Valve, Pintsch Gas, Sander, Steam Heat Material.
8	Shelf Hardware, Shop Tools, Metallic Packing, Lubricators and Gauge Glasses.
9	Pipe Fittings, Wire and Wire Cloth.
10	Upholstery Material, Carpets, etc.
11	Glass, Drugs, Paints, Sundries.
12	Water Service, Rubber and Leather Goods.
13	Station and Train Supplies.
14	Tool and Supply Boxes, Tables, Desks, etc.
15	
16	
17	Brake Beams, Bolsters, Car Castings and Forgings, Axles, Couplers, etc.
18	Cylinders, Engine Castings, Cabs, Tires, Firebox and Tank Steel.
19	Shop Lumber, All Kinds.
19B	Bridge and Building Lumber, Piling, etc.
20	Oil House Material, Oil, All Kinds, Varnishes, etc.
21	Coal, Coke, Brick and Foundry Supplies.
22	Scrap, All Kinds.

These cards show only the general class of items in each section, and if there is any question as to where a certain article may be found it is only necessary to refer to a detail index in the booth. At the present time thirty-seven telephones are in use, the central being located in the storehouse offices. Provision is made for the installation of 100 telephones.

Practically no shop men are allowed in the storehouse, and this means a considerable saving. The section foreman, who is a practical man, and thoroughly familiar with everything in his section, can get the material together in the shortest possible time, and a sufficient number of messengers are provided so that no time is lost in delivering it. The high-priced mechanic does not have to leave his work; he has no reasonable excuse for "killing time" by making unnecessary trips

to the storehouse, and an expensive machine does not lie idle while he is absent.

The storehouse is equipped with two automatic electric elevators, each of 5,000 lbs. capacity. The building is heated by the Sturtevant hot air system; exhaust steam from the power house with Webster vacuum return is used for heating the steam coils. The Sturtevant fans are driven by Crocker-Wheeler shunt wound 25-h.p. motors through Morse silent chain. In addition to the fire hydrants and fire apparatus the building is equipped with a sprinkler system. We are indebted for information to Mr. C. A. Seley, mechanical engineer, and Mr. H. C. Pearce, general storekeeper.

PIECEWORK IN THE PAINT SHOP.—After an experience of a number of years I am free to say that there is almost no limit to the amount of work which can be turned out from a well organized piece work shop. The greatest anxiety the foreman has is to get work enough to keep his men busy. No time need be spent watching the men to keep them from idling, the men will be active in seeing that the work is finished in time. They are all practically in business for themselves, and are always very loath to take as a partner any one who is not willing to do his share. Consequently, the lazy, indifferent workman soon loses caste among his fellows. With a good corps of honest, faithful inspectors the quality of the work likewise improves. The men soon find that it does not pay to do a job twice for the price they are to receive. Their ability becomes a matter of individual daily record which inspires a sense of self-respect which is much greater than by any other plan.—*Mr. H. M. Butts before the Master Car and Locomotive Painters' Association.*

In 1805 the world had not a single steamer upon the ocean, a single mile of railway on land, a single span of telegraph upon the continents, or a foot of cable beneath the ocean. In 1905 it has over 18,000 steam vessels, 500,000 miles of railway and more than 1,000,000 miles of land telegraph, while the very continents are bound together and given instantaneous communication by more than 200,000 miles of ocean cables, and the number of telephone messages sent aggregate 6,000 millions annually, one-half of them being in the United States alone. The world's international commerce which a single century ago was less than two billions of dollars, is now 22 billions, and the commerce of the Orient, which was less than 200 million dollars, is now nearly 3,000 millions.—*Mr. O. P. Austin, National Geographic Magazine.*

LOCOMOTIVE CYLINDERS.

BY HAL. R. STAFFORD.*

While no attempt will be made in this article to trace the history of locomotive cylinder design from the simple, primitive castings used on Stephenson's "Rocket" or the "Stourbridge Lion," which had nothing in common with those of to-day, except that they were made of cast iron—a practice which we have been unable to improve; to the 16 x 24 in. cylinder of our father's time, and, finally, to those of the 24 x 32 in. freighter of the present day—enough will be said to prove that we are to-day confronted with many problems besides those incident to mere increase in size.

The accompanying illustrations are typical of modern practice. Fig. 1 is a 22 x 32 in. slide-valve cylinder for a consolidation freight engine, and Fig. 2 is a 20 x 24 in. piston-valve cylinder, also for a consolidation engine. Both are of the "half-saddle" type, which has become practically the standard in this country, although several important roads still use the separate saddle type to a great extent.

In the separate saddle cylinder, as the name implies, the barrel and valve seat are cast separately from the saddle, the frame being "slabbed" to pass between them. This necessitates several extra joints in the steam connections, with consequently greater liability of leakage of steam to the atmosphere. Trouble is also experienced in preventing the working of cylinders on the frame, in spite of the great number of bolts and large frame keys now used. The principal advantage of this design is simplicity of castings, though, in the present day of advanced foundry practice, no difficulty is met with in casting cylinders with the half-saddle attached.

Referring to the commonly accepted type, the term cylinder in railway parlance to-day includes, besides the cylinder barrel and the valve seat, the "frame fit," or face for attaching to the frame, and the "saddle" by which it is secured to and supports the front end of the boiler by attachment to the smokebox. Given the diameter of the cylinder, length of stroke, height and radius of boiler, frame centers, cylinder centers, etc., the cylinder designer is asked to furnish a suitable casting, connecting the boiler rigidly to the frames and carrying the cylinder barrel, all steam passages to be as well protected from the atmosphere as possible, with a minimum of weight and a maximum of strength.

The cylinder shown in Fig. 1 has a somewhat high saddle, necessitated by its use under a boiler with a Wooten firebox. It will be noted that the steam inlet pipe is kept separate from the exhaust for the greater part of its length and, though its one side forms part of the outside wall, the saddle at this point is covered with magnesia lagging and jacketed with sheet iron. Builders sometimes go a little farther, carrying a lightening core between the steam pipe and the outside wall and another between the steam and exhaust pipes, under the frame rail; but as a certain amount of "dirt" washes from each of these small cores when the casting is poured, rising to the highest point in the mould, which is the barrel (cylinders being cast upside down), the necessity of having good metal at this point makes the multiplication of small lightening cores an undesirable practice. To avoid the difficulty of dirty barrels and also to keep the mould full as the metal shrinks, risers are cast upon the cylinder-cock bosses, and very frequently upon the frame fit, which is another region of frequent trouble. These are shown by the heavy dotted lines in Fig. 1.

Cylinders are gated at the back, where they bolt together, near the bottom of the mould. As the metal rises, it should have a free flow to all points, particularly to the barrel and frame fit, where, by the junction of many walls, there are apt to be masses of metal, which must be fed before it has time to become too cool. For this reason a horizontal wall, "x," Fig. 1, is often webbed around the steam and exhaust pipes, which forms a direct passage for the metal without its flowing in a circuitous route around the outside wall, or "stretcher."

The principal points to be kept in mind in arranging steam and exhaust passages in the saddle, are to avoid flat walls, to provide a direct route free from sudden bends, and of as nearly constant area as possible for the passage of steam. The exhaust, in particular, must have no large pockets to form eddies, but must be guided directly to the nozzle. The first piston-valve cylinders were particularly faulty in this respect, the exhaust filling much of the room which, in the later designs, is thrown into the lightening space. This large reservoir acted as a muffler on the exhaust, the sound being much the same as produced by a very leaky valve.

The proportions of cylinder barrels are subject to great variation among different builders. A common fault is too short a barrel, bringing the ports too close to the ends. This is a vital error, as an accident causing the breakage of a cylinder-head is apt to tear away this part of the flange, making a break that is almost impossible to repair. The design in Fig. 1 shows liberal metal at this point. Thickness of the barrel in locomotive cylinders is seldom found by rule, as in stationary and marine work, but is usually fixed upon with a view to boring out and bushing to original size when worn. It is becoming quite common practice to cast piston-valve cylinders of soft, easily machined iron of low shrinkage and to bush with much harder iron; by this means, all wearing surfaces are made more lasting, with less danger from shrinkage cracks, due to use of hard iron. With slide-valve cylinders, this would necessitate the use of a false valve seat in place of the piston valve bushing in the other case, and so is seldom done.

In bolting cylinders together, a double row of bolts should be used on cylinders of 18-in. bore and upward, and it is good practice to make several of the lower bolts, where the stress is greatest, of larger diameter than the rest. Bolting to the smokebox should also be in a double row, and the bolting flange should be of liberal thickness. It is hard to estimate the enormous strain borne by these bolts during severe shocks, due to switching or slight collisions, with the boiler carried at the height shown in Fig. 1. For the same reason, a liner, not less than $\frac{1}{2}$ in. thick, is always used to reinforce the smokebox sheet, extending well up the sides and usually the full length of the smokebox. The opening in the liner and the smokebox sheet for the passage of steam and exhaust pipes should be no larger than is necessary, but care should be taken in designing engines with single bar, continuous frames to see that the steam pipe boss on the cylinder is not too high to prevent its passing through this opening when the cylinder is withdrawn horizontally, otherwise it will be necessary to separate the frame from the boiler for its entire length when removing a cylinder.

Bolts to the frame should be so located that the nuts can be reached with a wrench, instead of being tightened with a set, as is often done. For that reason, a few well-placed bolts of large size are to be preferred to a number of small ones badly located. There should be at least one vertical bolt in each end of the frame fit, although these have been omitted in some recent piston-valve designs. Vertical bolts can not be of so large diameter as horizontal bolts, since the width of the frame is limited, while the depth may be increased to almost any extent at this point to make up for the metal removed by bolt holes. Top rails need not be bolted horizontally and vertical studs are of little use, all dependence being placed upon one or two vertical bolts at each end of the frame fit, with a key at the front and crossties shrunk on the frames at the front and back of the cylinders.

Cylinder-head studs are usually spaced too far apart to prevent springing of the head between holes. For a boiler pressure of 200 lbs. and upward, the pitch should not exceed $3\frac{1}{4}$ in. It will be found that $\frac{7}{8}$ in. studs, instead of 1 in., as are usually applied, will be amply strong with this spacing. A fiber stress of 7,000 to 8,000 lbs. is on the safe side, taking the diameter to the middle of the grinding joint as the surface on which the pressure acts. The same is true of steam chest studs on the slide-valve cylinders—smaller studs, closer together—although here we are limited by the stuffing box on

*American Locomotive Company, Schenectady, New York.

the chest passing between the studs. The fact is often overlooked that fiber stress on the studs is not the only thing to be taken into consideration. We seldom hear of a steam chest cover blowing off, but we do see covers and cylinder heads leaking because of the studs being spaced too far apart.

The piston valve is daily growing in favor, in spite of prejudice. As regards the cylinder casting, it has many advantages. The walls lend themselves more readily to curved lines than do those of the slide valve, the avoidance of flat walls exposed to steam pressure being one of the most important things to be considered in cylinder work. Designs are often seen with flat walls of great area stayed with tie pieces and ribs. These are a menace to the casting, as they generally either crack off or pull out a piece of the wall, according as they are heavy or light, in comparison with the adjoining metal. As piston valves can be made of any desirable length,

outside admission valves, the pressure exerted on the area of the valve stem must be counterbalanced by extending the stem through a stuffing box on the front end also: Then it makes a more free exhaust. When exhaust takes place toward the inside, the tendency is to flow first to the opposite end, where it is caught in the cup of the opposite bushing, striking that end of the valve and causing a jumping which is very noticeable when there is lost motion in the connections. Then, after expending most of its energy, it finds its way to the outlet. With inside admission valves, the shape of the steam chest cover can be made such that the exhaust finds a smooth course, free from eddies, to the nozzle.

With direct motion, the valve chest is placed almost directly above the frame, but should not be in too close proximity to the heavy mass of metal forming the frame fl. As has been said, this is one of the worst places for spongy metal, particu-

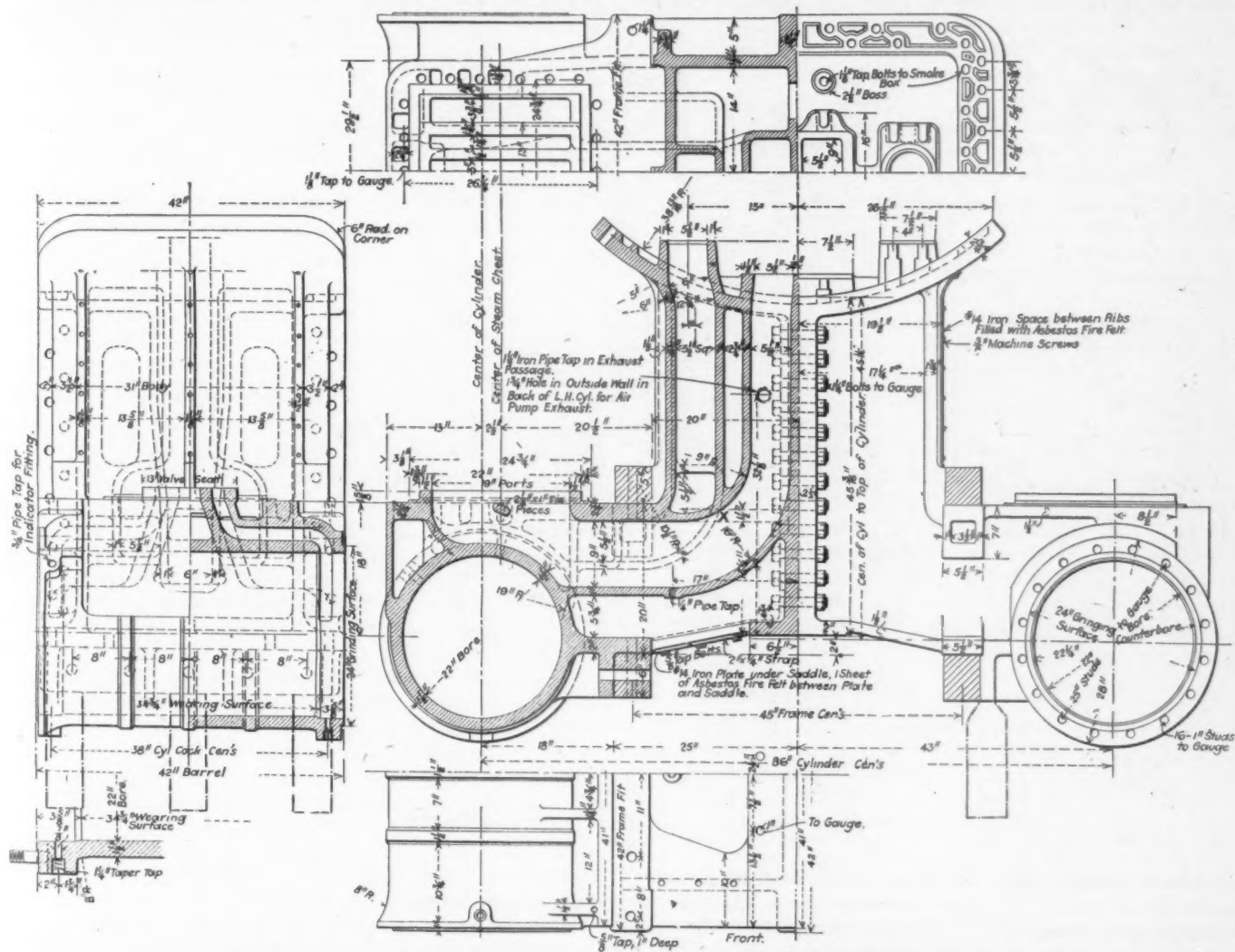


FIG. 1—22 BY 32 IN. SLIDE VALVE CYLINDER FOR CONSOLIDATION LOCOMOTIVE.

the steam ports can be made very short and direct. For this reason, also, the steam chest should be placed as close to the bore as will allow the barrel flange to be turned for the head casing. A reduction of clearance to 7 or $8\frac{1}{2}$ per cent. is thus easily secured, and even less can be obtained by a sacrifice of other desirable features.

The piston-valve cylinder, shown in Fig. 2, is for inside admission, with direct valve motion. For indirect motion, with either inside or outside admission, it would be necessary to place the valve chest almost directly above the cylinder barrel, as this would bring the valve stem in the same relative position as on a slide valve engine. Most piston-valve cylinders are arranged for inside admission, as this has several advantages: first, it brings the exhaust on the ends, lessening packing troubles—many roads use only hemp packing on piston valve stems. It makes the valve perfectly balanced, while, with

larly in piston-valve cylinders, and great care must be taken to avoid the missing of walls at this point. It will be observed in Fig. 2 that the steam ports pass very close to the frame, which is a source of danger, unless the metal is evenly distributed. The risers, previously mentioned, are particularly necessary on piston-valve cylinders. Another precaution is shown at "x," Fig. 2, a portion of the face of the frame fit over the port being set back about $\frac{1}{2}$ in., so that, in planing, this is left untouched, on the theory that the "skin" of a casting is most likely to prove of sound metal.

Do not tie the internal walls together with ribs in any type of cylinder, but leave them all possible freedom to expand and contract with changes of temperature relying on the box of the saddle for strength to resist the stresses due to the thrust of pistons, the racking of frames on curves, etc. It will be found that metal in the outside walls of the saddle is in the

best possible position to sustain these strains, and the addition of extra walls only adds weight, as well as endangering the casting. Small tie pieces, "y," Fig. 2, however, are always placed in "opening cores," i.e., steam ports, on account of the long, unsupported portion of the barrel flange necessitated by a wide port. These should run right to the counterbore, forming a guide for the piston rings when placing the piston in the cylinder.

Steam chests of piston-valve cylinders can readily be made self-draining, as in Fig. 2, while slide-valve chests must be kept clear of water by waste cocks operated preferably by a separate lever from that of the cylinder cocks, that they may be kept closed while running with the cylinder cocks open. This avoids the drainage of oil from the valves and pistons along with the water.

In the foundry also the piston-valve cylinder has points of superiority. Fig. 3 illustrates a modern method of setting cores in this type of cylinder, in which all steam and exhaust

be readily broken up and removed when the casting is cleaned. Each arbor has two or more eyes for the reception of the bolts by which it is joined to the foundation core. This core is made in halves, with half of a hollow cast iron center moulded in each, which central arbor is provided with a number of holes, through which the core bolts pass, with nuts on the inside. These nuts are tightened, securing the cores in place upon one-half of the foundation core at a time; the two are then drawn together by bolts in slotted holes in the end of the hollow arbor.

All joints have now to be treated in the usual manner, "pasted" together and covered with plumbago, a thorough skin drying being given by a gas torch, or other means. Sometimes they are treated to a second baking in a core oven, but this is rarely necessary. The whole is now ready for lowering into the mould. While the making of the cast iron arbors used in this method involves additional expense, the smaller percentage of lost castings, due to cores shifting, and the great

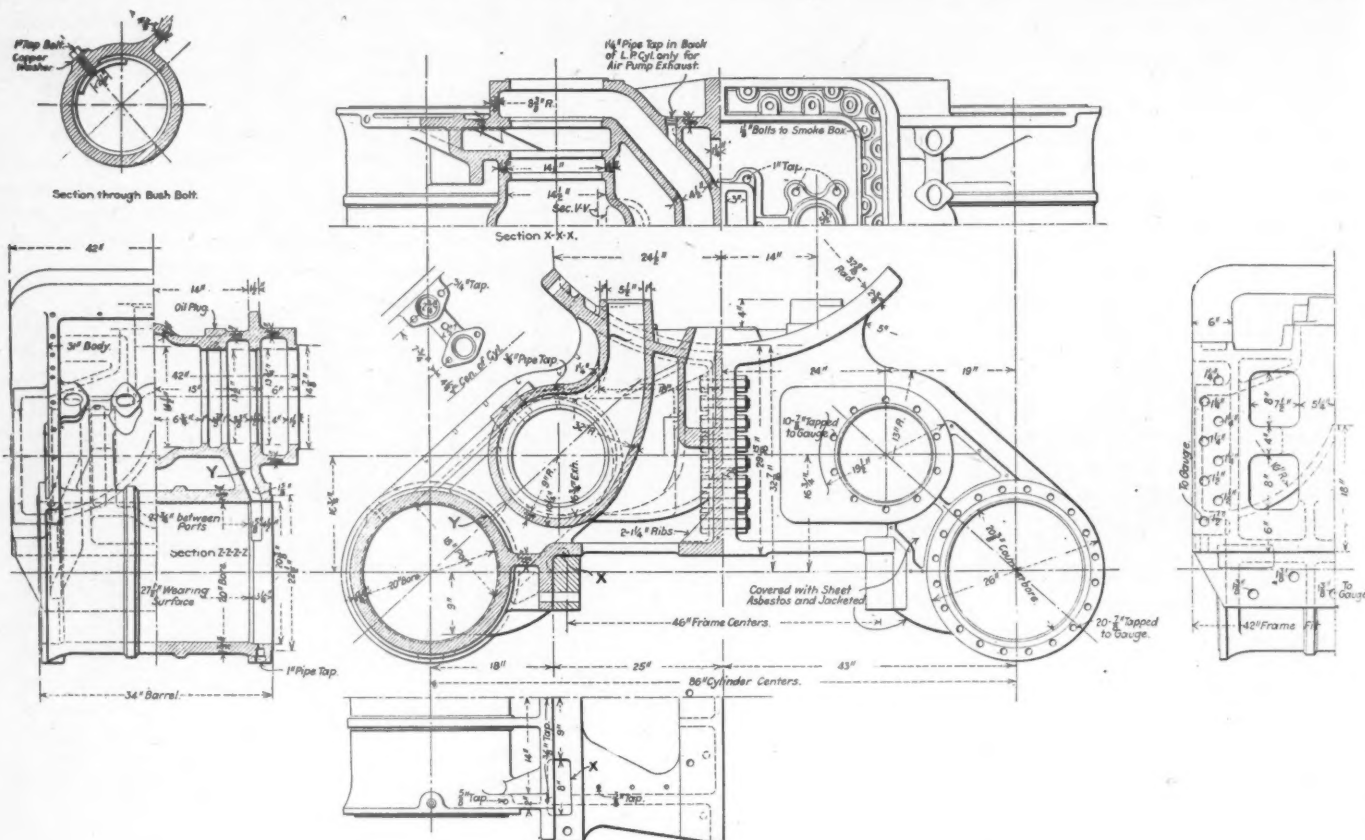


FIG. 2.—20 BY 24 IN. PISTON VALVE CYLINDER FOR CONSOLIDATION LOCOMOTIVE.

cores are rigidly joined together, being lowered into the mould in one piece. In order to do this, great care must be taken to make these cores of such shape that they will clear the lower half of the lightening cores (this means the upper half, referring to drawing), when lowered vertically into the mould. Lightening cores are divided on the horizontal line passing through the center of the steam chest, all between this line and the "deck" being placed in the mould previous to the lowering in of the steam and exhaust cores. This method eliminates all fins and passages where they are removed with difficulty, and often only half disposed of at that. Instances are numerous of old cylinders being broken up after years of service and the discovery made that one cylinder drew its steam supply through an opening no bigger than a knot hole. Many of the mysterious differences between engines of the same class are due to such causes.

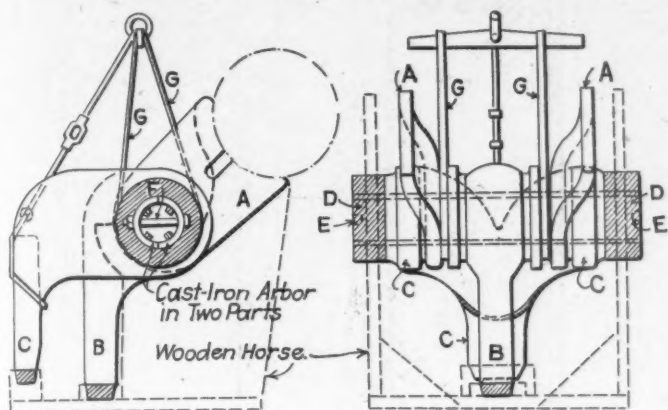
Referring to Fig. 3, it will be seen that the cores are assembled on a wooden "horse" and that the steam chest core forms the foundation of the whole structure, to which all other cores are secured by means of the special bolts shown. Each core has a cast iron arbor running through it besides the usual core irons. These arbors must be made light enough to

improvement of the quality of the work turned out make this really the most economical way in the long run.

In the design of new cylinders, the drawing room and the shop must cooperate. To send out the drawing of a radically new type, a drawing which is the product of the engineering department, without consultation with the pattern-maker is to invite trouble—at least, to pile up unnecessary expense. It is also of greatest importance that the engineer does not confine himself to the consideration of design only, but follows the work through the pattern shop and the foundry to see that his ideas are carried out. It is commendable practice to break up a cylinder from each new pattern—one that has proved defective, if there should be one; otherwise, a sound casting, upon which no machine work has been done. The pieces are then carefully checked from the drawing and the thickness noted. Any sharp corners on the steam or lightening cores should call for comment; fillets should be put in the core boxes and not left for the core-maker to attend to. There is a tendency for pattern-makers and core-makers to be on the "safe side"—too far—in calculating the thickness of metal: 1-in. walls becoming $1\frac{1}{8}$ -in., and $1\frac{1}{2}$ -in. walls about $1\frac{3}{4}$ -in. through a system of double allowance for swelling of cores; the pattern

shop makes one allowance, then the core-maker slicks off still more, with the result that castings greatly overrun the estimated weight. Rigid inspection under the drop is the only sure way of detecting these practices.

Compound cylinders introduce so many complications and



- A - Opening Cores.
- B - Steam Core
- C - Exhaust Core.
- D - Prints on St. Chest Core.
- E - Slots for Bolts-F
- F - Bolts for Holding Halves of Arbor Together
- G - Slings.



FIG. 3.—METHOD OF SETTING CORES IN PISTON VALVE CYLINDER.

such infinite variety as to be quite beyond the scope of so brief an article. With these, as with simple cylinders, the design of walls and passages for resisting steam pressure, machinery strains, shrinkage, etc., is more a matter of common sense and experience than mathematics.

THIRD MAN ON LOCOMOTIVES.

A few years ago a fireman was required to clean his own fires, hoe out the ash pan, spark the front end, and when he arrived at the terminal his labors had just began, for he had the engine to clean inside and out, also brass to scour; while at present he is relieved of the cleaning almost entirely, and with the modern locomotive he has been relieved of the duty of cleaning fires and ash pans and sparking front ends.

The hardship of a fireman at the present day, in our opinion, is not what it is pictured. He has very little to do except to put the coal into the firebox.

If our divisions are too long, making it impossible for one man to cover the division, cut the division in two and have a fresh man on the engine.

In correspondence with a road that tried the experiment of placing the third man on an engine, it was given as their experience that the method was not at all satisfactory. Friction developed right from the start, and, taken as a whole, not much, if any, better results were obtained than with one fireman. The best results have been obtained by making shorter divisions for men firing the heaviest locomotives.

We are not in favor of the third man on the engine in any capacity.—*From a committee report, before Traveling Engineers' Association.*

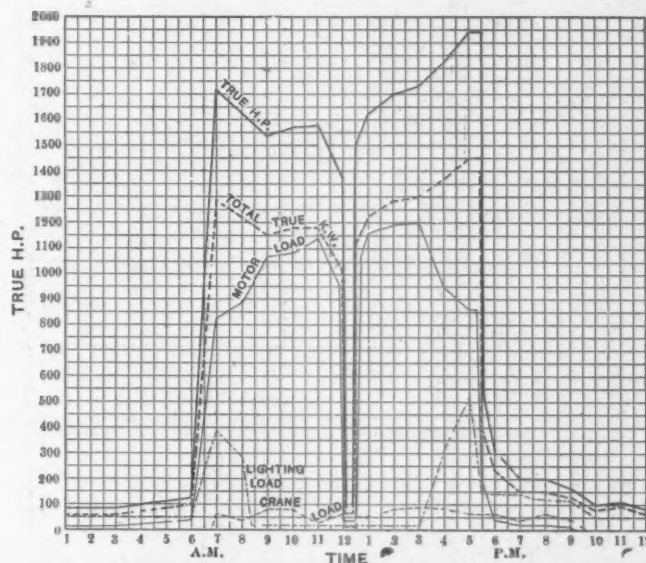
GAS VERSUS STEAM FOR POWER.—Moreover, when we consider that a central station, if equipped with a gas plant, will involve a capital outlay approximately the same as with a steam plant, and that the actual fuel consumption, if worked at full load continuously, will be reduced in the proportion of 100 to 83, and, if, worked with a load factor of 25 per cent., in the proportion of 100 to 35, then we are bound to acknowledge the superiority of the gas system, and adopt it wherever power plants are to work with the highest commercial economy.—*Mr. F. E. Junge in Power.*

POWER DISTRIBUTION, ANGUS SHOPS.

The accompanying diagram shows the distribution of power for December 22, 1904, at the Angus shops of the Canadian Pacific Railway at Montreal, the power house of which was described on page 75 of our May journal. The maximum load was 1,940 h.p., while the average load from 7 a. m. to 5.30 p. m. was 1,560 h.p. The load factor was 80 per cent. and the power factor of the maximum load was 68. For the entire 24 hours the average load was 850 h.p. and the load factor was 44 per cent. The weather was stormy.

The curves were plotted from the hourly indicating watt-meter records taken from the power house report and this accounts for the power being shown as increasing uniformly between 6 and 7 a. m., while as a matter of fact the increase is quite abrupt at 7 a. m. The motor load remains at practically zero up to 6 a. m., when it increases as the motors operating the fans in the blacksmith shop are started and the fires made ready for 7 a. m., at which time the full load comes on, and this gradually increases as the workmen get into the swing of the day's work, until 11 a. m., at which time the large blower motors in the foundries are started. The load drops off at 12 o'clock noon, starts up again at 12.30 p. m., and remains fairly constant until 3 p. m., when it gradually falls off as the men finish their piece work.

During the winter months the full lighting load is switched on at 7 a. m. and gradually diminishes as the day brightens. At 3 p. m. it gradually begins to increase again and reaches a maximum at 5 p. m. The lights used for general lighting are so greatly in excess of the individual machine lights that



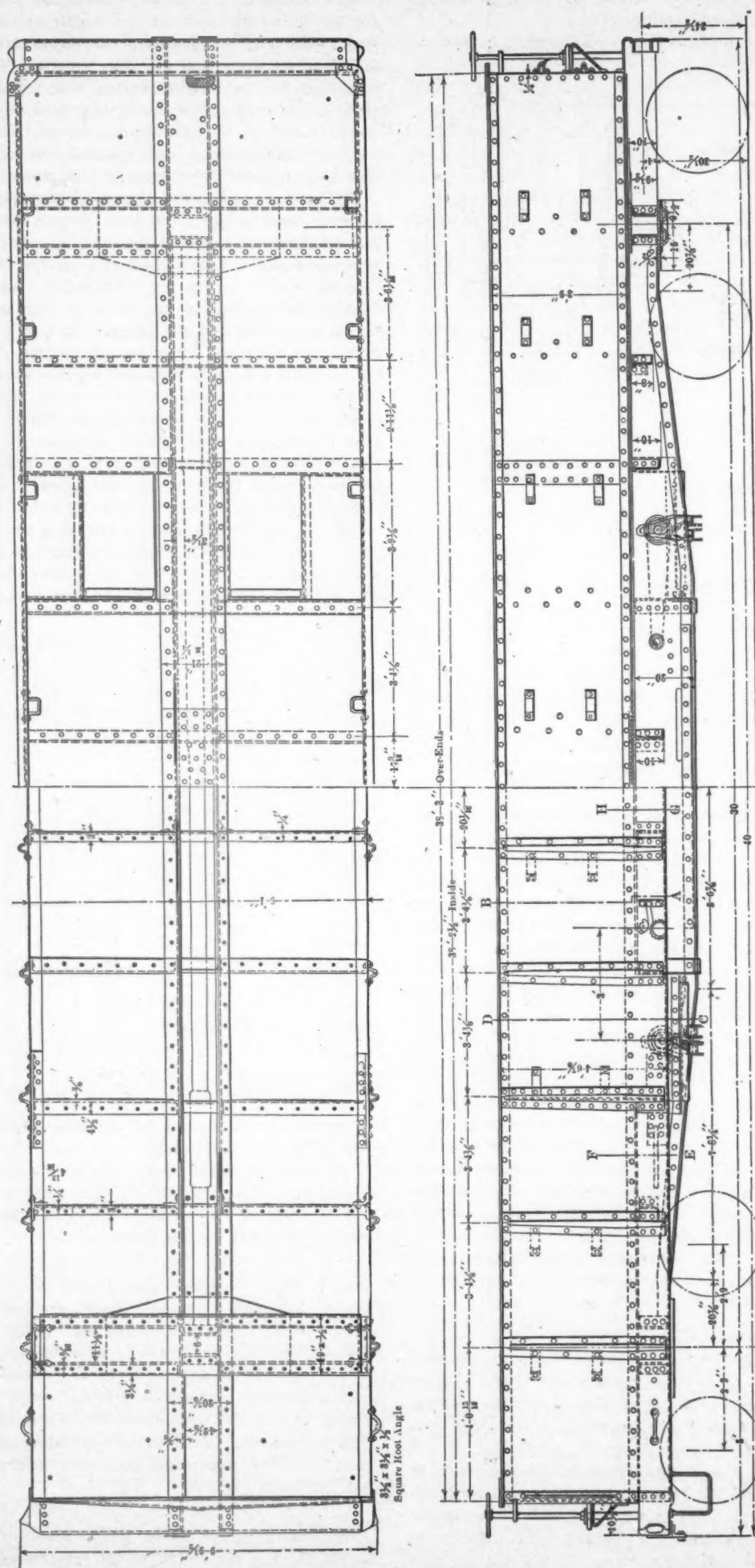
DISTRIBUTION OF POWER—ANGUS SHOPS.

the lighting load is not appreciably affected by the piece workers as they stop work.

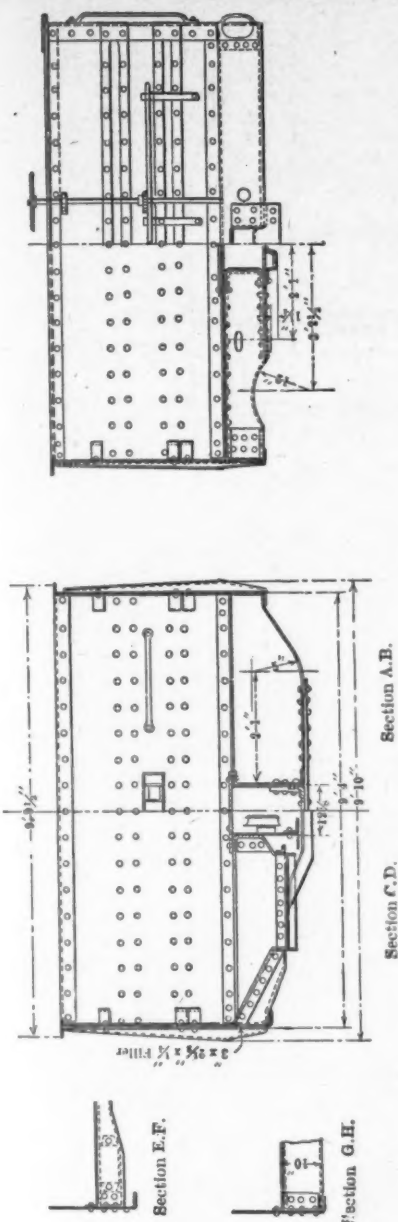
The cranes in the erecting side of the locomotive shop are in almost constant use up to 8.30 or 9 p. m. The heavy work is preferably done after hours in order to prevent any delay of the work on the locomotive.

PAINT SHOP FLOORS.—The Master Car and Locomotive Painters Association at their recent convention voted that it was the sense of the convention that either cement or brick floors, if properly constructed, were most suitable for paint shops. The arguments in favor of cement were that it is easily kept clean, absorbs very little water, is easily drained, is hard and smooth, generates very little dust, and the cost of installation and maintenance is comparatively low. Practically the same arguments hold true in the case of vitrified brick laid with cement.

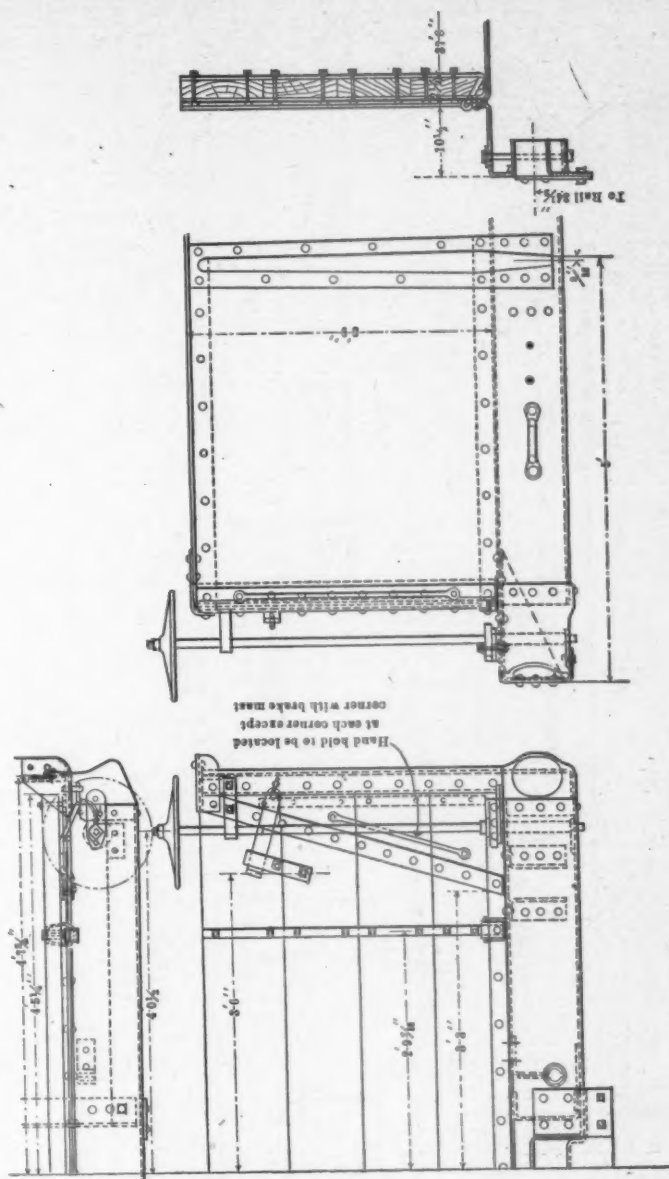
Compressing air to 100-lb. gauge pressure requires approximately $1\frac{1}{2}$ h.p. per cu. ft. of air compressed.



PLAN AND SIDE ELEVATION OF GSA AND GSC 50 TON GONDOLA CARS.
PENNSYLVANIA RAILROAD.



CROSS SECTIONS AND END VIEWS 10 TON GSA GONDOLA CARS.



DROP ENDS FOR GSB AND GSC 50 TON GONDOLA CARS.

STEEL CAR DEVELOPMENT ON THE PENNSYLVANIA RAILROAD.

IX.

(For previous article, see page 436, Volume LXXIX.)

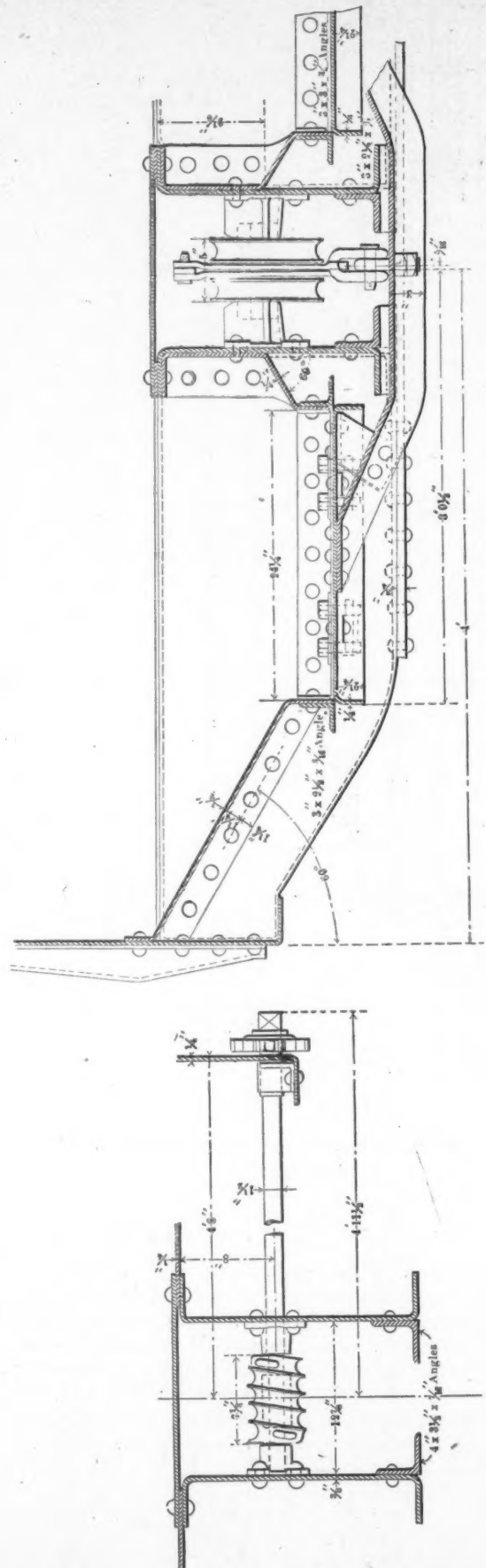
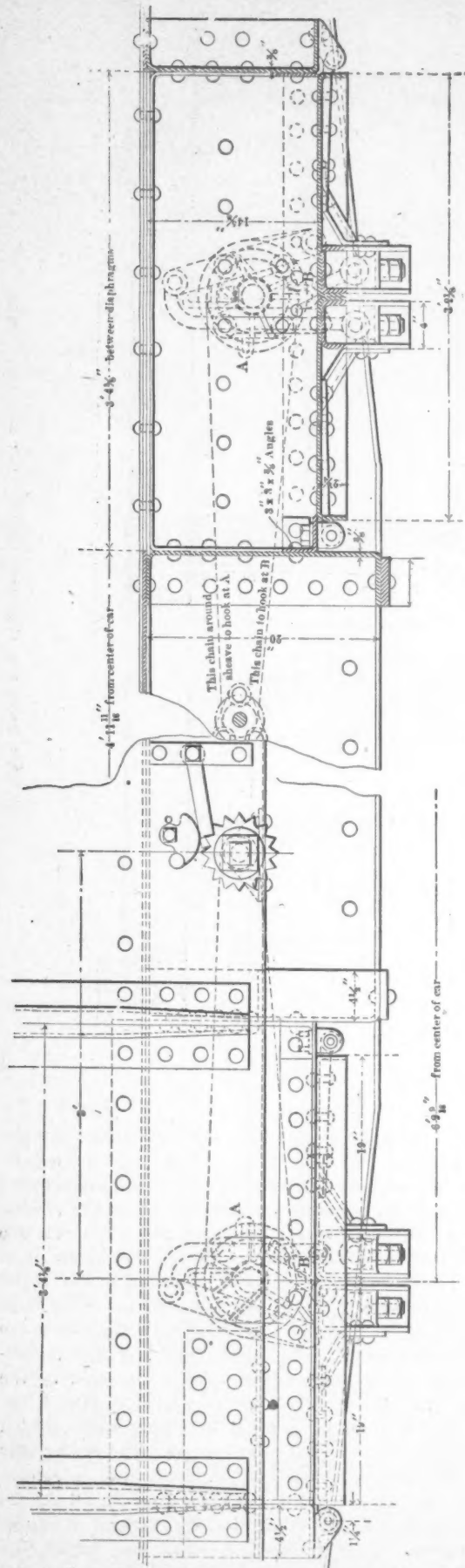
The Gs classes of gondola cars, of which there are four, viz., Gs, GSA, GSB and GSC, have 20-in. center sills as a backbone, but no side sills. These cars were designed for distributed loads. The Gs and GSA classes have fixed ends. The GSB and GSC have drop ends, and the GSA and GSC drop bottoms, all of the Gs sub-classes being generally alike, except as to the ends and the drop bottoms. The weights and capacities of the Gs classes are as follows:

Class.	Capacity, cu. ft. level.	Capacity, cu. ft. heaped.	Light weight.
Gs.....	1331.25	1597.5	38,500 lbs.
GSA.....	1379.25	1645.5	40,000 "
GSB.....	1312.5	1575	38,500 "
GSC.....	1360.5	1623	40,000 "

These cars are not intended for highly concentrated loads, but only for coal and similar loads generally distributed over the full length. The Gs cars are of the same length over end sills and between truck centers as the Gz classes. The length inside is 38 ft. 2½ ins., and the width inside 9 ft. 3½ ins., and the sides are 3 ft. 9 ins. high. The center sills are similar to those of class Gz, except that they are not

quite as deep. In place of side sills the side sheets are extended 10 ins. below the floor of the car and are flanged inwardly at the bottom. The cross members of the underframe are in the form of pressed steel diaphragms which are riveted at their ends to the side plates. The side and end sheets are of ¼-in. steel with coping angles at the top and stiffened at the sides with 10 pressed steel stakes reaching down to the bottom of the side sheets, where they are riveted to the ends of the cross members. The drop ends of the cars which are provided with these ends are of 2½-in. plank. The drop bottom mechanism for the GSA and GSC cars is operated by the Simonton operating device, which is illustrated in one of the engravings. The GSA design is fitted with coke racks, which are also illustrated in one of the engravings. The center sills provide for the Westinghouse friction draft gear arranged between them, the same arrangement being used on all the Gs classes. For the purpose of illustration, the general drawings of the GSA and GSC classes are used, the draft gear for all four classes, the drop ends for the GSB and GSC, the coke rack for the GSA and the drop doors for the GSA and GSC.

For convenience in reference descriptions of the steel cars of the Pennsylvania Railroad will be found in this journal as follows: October, 1903, page 352; November, 1903, page 402; December, 1903, page 435; January, 1904, page 3; June, 1904, page 209; May, 1905, page 148; October, 1905, page 358; December, 1905, page 436.

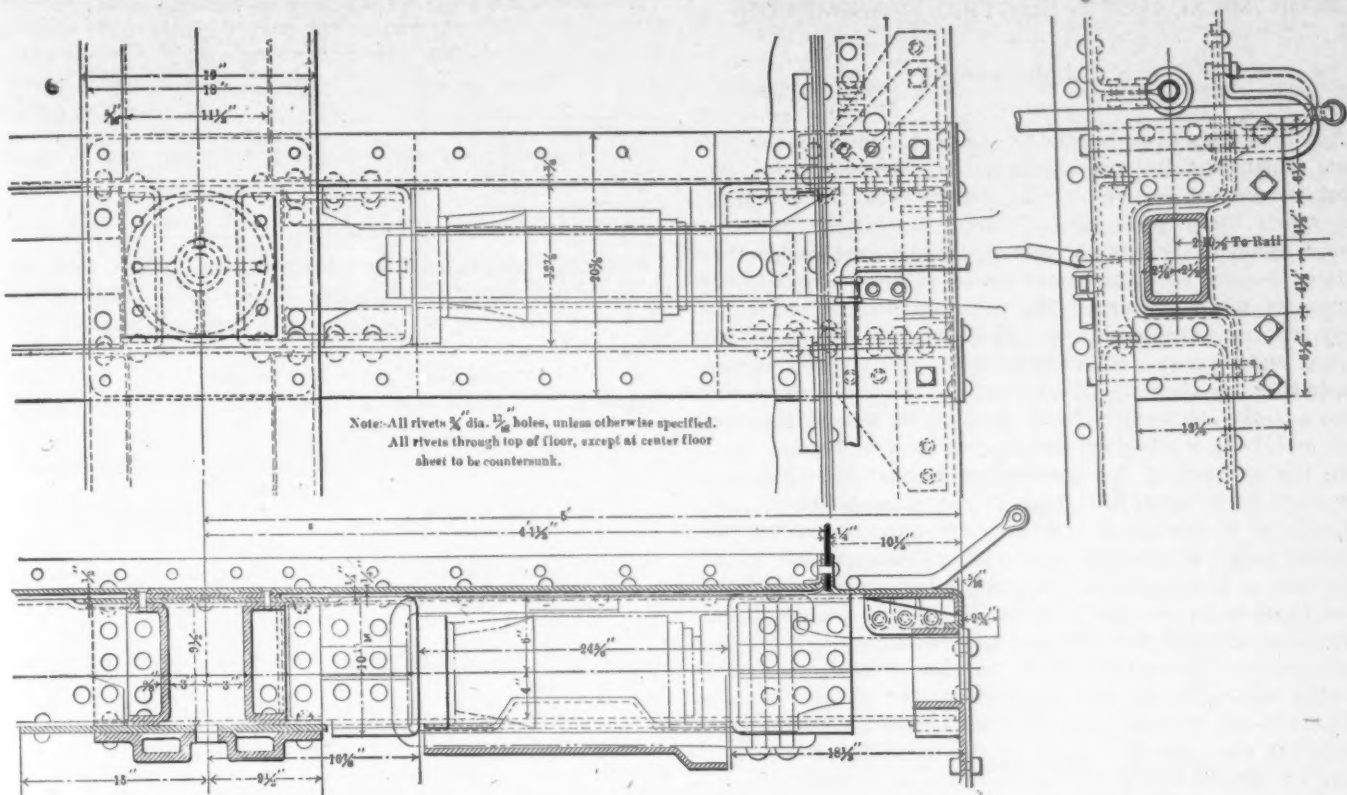


GENERAL ARRANGEMENT OF DROP DOORS FOR GSA AND GSC 50 TON GONDOLA CARS.

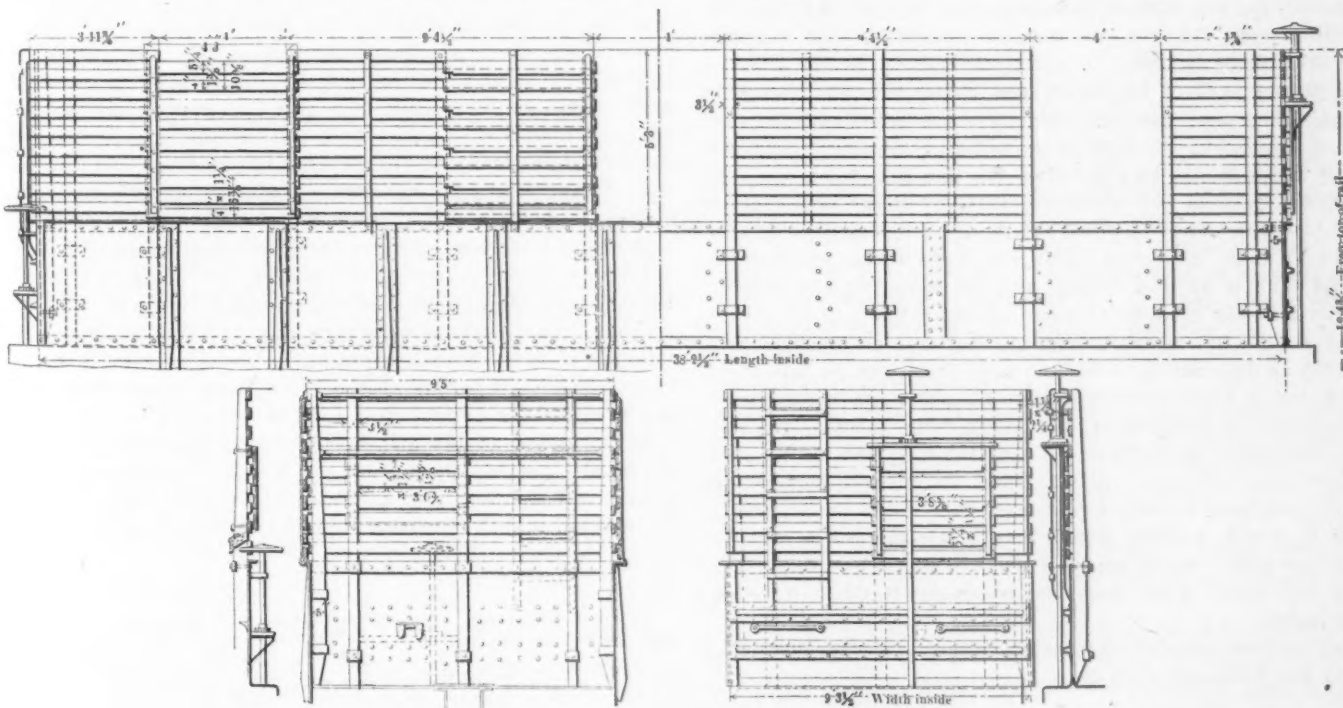
PENNSYLVANIA RAILROAD.

PASSENGER TRAFFIC IN NEW YORK.—When it is remembered that the Manhattan elevated and subway systems alone, on but a little over fifty miles of road, carry two-thirds as many passengers as do the steam railroads of the United States on over 200,000 miles, it needs no demonstration to show that the number of passengers interchanged with the Grand Central Station, the terminus not only of the New York Central system, but of the New England railroads as well, does not con-

stitute a large percentage. Even in London, where the facilities are inferior to an American city, the board of engineers in their report advising the royal commission show that one trolley terminus, where the lines, through opposition, are compelled to stop short of ultimate destination, discharges and receives more passengers than are similarly handled at six large railroad passenger stations combined.—*W. B. Parsons, before Purdue students.*



APPLICATION OF WESTINGHOUSE FRICTION DRAFT GEAR TO GS, GSA, GSB AND GSC GONDOLA CARS.



APPLICATION OF COKE RACKS TO GSA GONDOLA CARS

LEAKAGE THROUGH SLIDE VALVES.—In the report of the Steam Engine Research Committee of the Institution of Mechanical Engineers (England) the following conclusions are given concerning elaborate tests on the leakage of steam through slide valves: (1) That leakage through the slide valve, quantitatively determined the first time, is shown to be practically independent of the speed of the sliding surface, directly proportional to the difference of pressure between the two sides of the valve, and, to an approximate extent, inversely proportional to the over-lap of the valve. (2) That even with well fitted slide valves the leakage may represent more than 20 per cent., and is rarely less than 4 per cent. of the total steam entering the cylinder.

REQUISITES OF A SUCCESSFUL ENGINEER.—Master every detail of the work you are responsible for until you understand how it should be done and why. Then shed that detail as fast as you can on your subordinates. Aim always that you shall know at least as much, if not more, about the work than any subordinate; that no one under you shall long or permanently know more that is important about it than you. Get as big men under you as you can, but try always to be bigger yourself, and if that implies fresh study and fresh work, do it. Through all your work, and especially if you are called to executive positions, stand squarely for what is right; for integrity, straightforwardness and honest dealing.—Henry R. Towne at Purdue University.

ECONOMICAL LOSS IN ELECTRIC TRANSMISSION.

BY G. R. HENDERSON.

Nearly twenty-five years ago, Lord Kelvin pointed out that, considering the annual charge on invested capital, the most economical section of an electrical conductor is that for which the annual cost of energy wasted in transmission is equal to the annual interest and depreciation on that part of the cost of transmission which is proportional to the section of the conductors. The great number of plants for electrical transmission put in nowadays by railroads, makes a clear understanding of this proposition very interesting and important. Particularly is this the case when a definite and fixed quantity of work is to be done at the end of the line, such as driving a pump by means of an electric motor.

In the solution of this problem, there are three principal factors to be determined, the cost of the transmission line, the initial cost of the plant, and the cost of operation. If we consider such transmission to be made without any line losses whatever, it is evident that our generating plant would only have to be large enough to deliver the power needed at the consuming end, and that the cost of operation would cover the same amount. No matter what the size of conductors used (within reasonable limits), the same number of poles and insulators would be used, and the cost of setting up the line would not vary greatly; nor would the insulation of the wire form an important factor. As the loss in transmission depends chiefly upon the size of wire used (assuming a given distance and power), we can consider the amount of copper required as the variable affecting the cost of the line, depending upon the line loss, and the larger the wire, the less the percentage of loss.

With the cost of the plant and operation, the reverse is true; the greater the loss, the larger the plant and the cost of running it; in any case, there will be a minimum limit for both, which would be reached if the line loss were non-existent, but just as this loss increases, so these two charges will increase. That is to say, if there be 10 per cent. lost in the line, then the power plant will have to be 10 per cent. larger than if no loss existed, and the operating cost will be proportionately greater, in some of the items.

As a rule, the excess power will not cost as much in proportion as that which would be needed to satisfy the minimum limit, but it will be considerable. It might not be necessary to enlarge the building to accommodate the extra size of engine and boiler necessitated by the line loss, nor the number of men required to run the plant, but the engines, boilers and generators must be larger, and more fuel would be consumed. This is stated in some detail, that a fair allowance may be made for such "excess" plant, where by "excess" we mean that over and above what would be necessary if there were no line losses.

Let us first consider the cost of copper wire in our lines, using the following notation:

D = Distance of transmission (one way) in feet.
K = Kilowatts to be delivered at distant motor.
l = Percentage of K that is lost in the line.
V = Voltage at distant (motor) end.
W = Pounds of copper in line (including all wires).
c = Cost of copper wire per lb. in dollars.
A, B, = Constants to be selected from tables.

Then the cost of copper in the line for one per cent. loss =

$$L_1 = \frac{D^2 K c A B}{1,000 V^2} \quad (1)$$

$$\text{and for any loss } L = \frac{L_1}{1} = \frac{D^2 K c A B}{1,000 V^2} \quad (2)$$

If r = the rate of interest paid on bonds, etc., for capital expenditure, we have the annual charge for such line for 1 per cent. line loss =

$$L_a = \frac{D^2 K c A B r}{100,000 V^2} = \frac{L_1 r}{100} \quad (3)$$

$$\text{and for any loss, } \frac{L_a}{1} \quad (4)$$

In these formulae A and B should have the following values:

SYSTEM.	VALUES OF A.	VALUES OF B.				
		PER CENT. POWER FACTOR.				
		100	95	90	85	80
Direct or single-phase alternating.	6.04	2,160	2,400	2,660	3,000	3,380
Two-phase alternating (4 wire).....	12.08	1,080	1,200	1,330	1,500	1,690
Three-phase alternating (3 wire)...	9.06	1,080	1,200	1,330	1,500	1,690

Example: Transmission of 150 k.w. direct current, for 2,000 ft., with 220 volts at the motor, copper wire being 16 2/3 cents per pound, or 6 lbs. for one dollar, and interest rate being 5 per cent.

$$4,000,000 \times 150 \times 6.04 \times 2,160$$

$$\text{Then } L_1 = \frac{6 \times 1,000 \times 48,400}{26,954 \times 5} = \$26,954, \text{ which}$$

would be the cost of line for one per cent. drop, and the annual rate on this would be $L_a = \frac{26,954 \times 5}{100} = \$1,347$.

These values divided by the loss, give the corresponding cost; thus for 10 per cent. loss, the cost of wires would be $\frac{L_1}{10} = \frac{26,954}{10} = \$2,695$, as per formula 2, and the interest

$$\frac{1}{10} \frac{L_a}{10} = \frac{1,347}{10} = \$134.$$

We find that the cost of the line will be practically fixed when the distance, power, system and potential are determined (as they naturally will be), except as to the drop, which, therefore, becomes the variable for this expression.

We must secondly discuss the cost of "excess plant" required. To begin with, we must know this amount per kilowatt generated. Dynamos may cost in the neighborhood of \$15 per k.w., but engines and boilers are usually figured by the h.p., and, of course, the type of plant has much to do with this factor. If we estimate engines @ \$15 per h.p., boilers @ \$14 per h.p., pumps and heaters @ \$1 per h.p., piping @ \$5 per h.p., chimney @ \$4 per h.p., housing @ \$11 per h.p., we have a total of \$50 per h.p. If condensers, economizers and mechanical stokers are used, the cost will be greater; if gas engines or other prime movers are used, the estimate must be figured accordingly. As there are 746 watts to an electrical h.p., the cost per k.w. would run about \$65, and with \$15 for generators, a total of \$80 per k.w. But unit prices decrease as the size of machinery increases, so that we should probably assume \$60 per k.w. for the "excess" over the delivered power. For a loss of 1 per cent. (necessitating an increase in power station of 1 per cent.) we should have

$$P_1 = \frac{pK}{100} \quad (5)$$

Where p = the cost of plant per kilowatt of excess, and for any loss, the excess cost will be

$$P = P_1 l = \frac{pKl}{100} \quad (6)$$

Similarly the annual interest will be on 1 per cent. loss,

$$P_a = \frac{pKr}{10,000} = \frac{P_1 r}{100} \quad (7)$$

and for any special loss, $P_{a1} \dots \dots \dots (8)$

Thus for our previous example, the "excess" plant, based on above figures, would stand for 1 per cent. loss (eq. 5)

$$P_1 = \frac{60 \times 150}{100} = \$90, \text{ or for 10 per cent.}$$

loss, $P_{a1} = 90 \times 10 = \900 , and the interest on these amounts, \$4.50 and \$45, respectively.

The third item, cost of operation per year, depends on the plant and the method and hours of operation. Generally the cost of fuel is the heaviest individual expense, but in any case, the cost can be approximately determined per year when the purposes of the installation are known. The charges should, of course, include depreciation and repairs, as well as labor. In a plant recently figured, with very cheap fuel, the amount was \$12 per year per h.p., although in many cases

it might run three or four times that amount. This would make the cost per k.w.-year about \$16. If we let this annual charge be represented by n and the same at one per cent. by Na we have:

$$Na = \frac{nK}{100} \dots\dots\dots (9)$$

and the annual charge for any loss will be

$$Nal \dots\dots\dots (10)$$

or at \$16 per kilowatt year = n ,

$$Na = \frac{16 \times 150}{100} = \$24, \text{ or for 10 per cent. loss}$$

$Nal = 24 \times 10 = \$240$ per year.

We are now ready to combine these data, and it is evident that the total cost per year, including interest on the invested capital =

$$Ta = \frac{La}{i} + Pal + Nal \dots\dots\dots (11)$$

Now by calculus, we can obtain the amount of loss " l ," which will produce the lowest annual cost, thus:

$$dTa = Padl + Nadl - \frac{La}{l^2} dl$$

$$\frac{dTa}{dl} = Pa + Na - \frac{La}{l^2} = 0 \text{ for a minimum value of } l, \text{ and, therefore,}$$

$$\frac{La}{l^2} = Pa + Na, l^2 = \frac{La}{Pa + Na} \text{ and } l = \sqrt{\frac{La}{Pa + Na}} \dots\dots\dots (12)$$

This last equation (12) gives us the minimum cost per year, including operation and interest on investment.

Let us now apply it to our previous figures. In these, $La = 1,347$, $Pa = 4.50$, and $Na = 24$, therefore,

$$l = \sqrt{\frac{1,347}{4.5 + 24}} = \sqrt{\frac{1,347}{28.5}} = \sqrt{47.3} = 6.88, \text{ or very nearly 7 per cent. loss. If we substitute this value of } l \text{ in equation 11, we obtain}$$

$$Ta = \frac{1,347}{6.88} + 4.50 \times 6.88 + 24 \times 6.88 = \frac{1,347}{6.88} + 28.5 \times 6.88 = 196 + 196 = \$392 \text{ per year.}$$

Now in this formula (No. 11), the annual cost of wasted energy is $Pal + Nal = 28.5 \times 6.88 = 196$, and the annual interest (no depreciation allowed on the line wires) on the portion of cost which is proportional to the section of the conductors is evidently

$\frac{La}{l} = \frac{1,347}{6.88} = 196$, as La is based on the cost of the conducting wires, which evidently is proportional to their sectional area, as shown by formula 3, and as both values are 196, they are equal, and prove Lord Kelvin's proposition. By substituting 5, 7 and 10 for l in equation 11, we can obtain the cost per year at each loss, and from formulae 2 and 6 the cost of the "excess" capital, due to line losses. These are given in the following table:

COMPARATIVE COST.

LINE LOSSES.	5 %	7 %	10 %
Cost of copper in line.....	\$5,391	\$3,851	\$2,695
Cost of "excess" plant.....	450	630	900
Total excess and wire.....	\$5,841	\$4,481	\$3,595
Annual interest on wire.....	269	193	134
Annual interest on excess plant.....	23	32	45
Annual operating cost on excess plant	120	168	240
Total annual cost and interest...	\$412	\$393	\$419

Our minimum annual cost was \$392 at 6.88 per cent. line loss as found previously, and 7 per cent. is only one dollar greater. The annual costs of operating at 5 and at 10 per cent. loss are very nearly the same—only \$7 difference between them, but there is a difference of nearly \$2,250 in the cost of installation, in favor of the 10 per cent. line loss, and while the interest on the increased cost is included in the operating expenses, it is seldom that the extra outlay would be desirable, unless for purposes of regulation under a variable load.

THE DIFFICULTY WITH THE LARGE SHOP.—A good organization is absolutely necessary to get good results, whether a shop be large or small, but the larger the shop the greater are the opportunities for a poor organization to become conspicuous and wasteful. The larger the shop the more difficult it is to find the right kind of superintendent and foremen to manage it, and the more they can earn for a railroad company, their possibilities are greater in proportion to the amount of work done.—*Mr. M. K. Barnum, before the Western Railway Club.*

WHAT CONSTITUTES AN "ENGINE FAILURE"

Because of great differences in the definition of what are known as "engine failures" on different roads there is an opportunity for misunderstanding, which may, perhaps, cause a serious reflection upon the motive power department, which is not merited, but is occasioned by the fact that these records are not all kept upon a uniform or standard basis. For example: some roads report as an engine failure anything whatever that delays a train over two minutes on the road, which is chargeable in any way to the locomotive, whether or not such time is subsequently made up. Other roads count only breakdowns, and because of the uncertainty of what an "engine failure" is, it seems advisable to urge the Master Mechanics' Association to take steps for an officially recognized definition.

The Chicago & Northwestern Railway has made the definition of an "engine failure" the subject of an official circular, which has been in effect for several years, and is reproduced below. The object of a general understanding of this subject is to permit of securing accurate information as to delays on the road and the reasons for them. A study of this circular will indicate some of the points which should be covered:

CHICAGO & NORTHWESTERN RAILWAY COMPANY.

DEFINITION OF WHAT CONSTITUTES AN ENGINE FAILURE.

1. All delays waiting for an engine at an initial terminal, except in cases where an engine must be turned and does not arrive in time to be despatched and cared for before leaving time.
2. All delays on account of engines breaking down, running hot, not steaming well, or having to reduce tonnage on account of defective engine, making a delay at a terminal, a meeting point, a junction connection, or delaying other traffic.

DELAYS THAT SHOULD NOT BE CONSIDERED AN ENGINE FAILURE.

1. Do not report cases where engines lose time and afterwards regain it without delay to connections or other traffic.
2. In cases where a passenger or scheduled freight train is delayed from other causes, and an engine (having a defect) makes up more time than it loses on its own account, should not be called an engine failure.
3. Do not report delays to passenger trains when they are less than five minutes late at terminals or junction points.
4. Do not report delays to scheduled freight trains when they are less than twenty minutes late at terminals or junction points.
5. Do not report delays when an engine is given excess of tonnage and stalls on a hill, providing the engine is working and steaming well.
6. Do not report delays on extra dead freight trains if the run is made in less hours than the miles divided by ten.
7. Do not report engine failures on account of engines steaming poorly, or flues leaking, on any run where the engine has been delayed on sidetracks other than by defects of engine, or on the road an unreasonable length of time: say fifteen hours or more per 100 miles.
8. Do not report an engine failure for reasonable delays in cleaning fires and ash pans on the road.
9. Do not report failures against engines that are coming from outside points to the shops for repairs.
10. Do not report cases where an engine is held in the roundhouse for needed repairs, and called for by the operating department, they being informed that the engine will not be ready until a stated time. Failure to provide that engine before that stated time should not be called an engine failure.
11. Do not report broken draft rigging on engines and tenders caused by air being set on train, account of bursting hose or breaking in two.
12. Do not report delays to fast schedule trains when the weather conditions are such that it is impossible to make the

time, providing the engine is working and steaming well.

13. Do not report delays when an engine gets out of coal and water, caused by being held between coal and water stations an unreasonable length of time.

EMPLOYEES ON AMERICAN RAILROADS.

The number of persons on the payrolls of the railways in the United States, as returned to the Interstate Commerce Commission for June 30, 1904, was 1,296,121, or 611 per 100 miles of line. These figures, when compared with corresponding ones for the year 1903, show a decrease of 16,416 in the number of employees, or 28 per 100 miles of line. The classification of employees includes enginemen, 52,451; firemen, 55,004; conductors, 39,645, and other trainmen, 106,734. There were 46,262 switch tenders, crossing tenders and watchmen. With regard to the four general divisions of railway employment, it appears that general administration required the services of 48,746 employees; maintenance of way and structures, 415,721 employees; maintenance of equipment, 261,819 employees, and conducting transportation, 566,798 employees. This statement disregards a few employees of which no assignment was made.

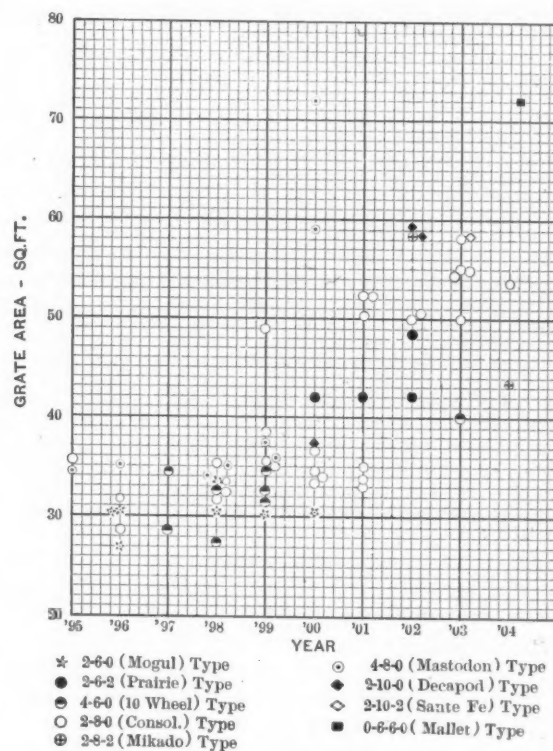
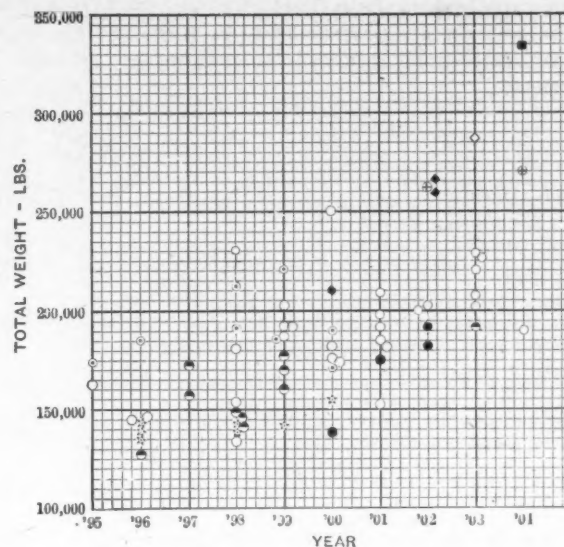
The usual statement of the average daily compensation of the 18 classes of employees for a series of years is continued in the present report, which shows also the aggregate amount of compensation paid to more than 99 per cent. of the number of employees for the year 1904, 97 per cent. for the year 1903, and more than 99 per cent. for the five years preceding. The amount of wages and salaries paid to employees during the year ending June 30, 1904, as reported, was \$817,598,810.

LOCOMOTIVE PROGRESS.

The demands on both passenger and freight locomotives have increased very greatly during the past decade and have necessitated a corresponding increase in the size and capacity of the locomotives, which has made necessary some radical changes in their design and construction. As the service has become more severe certain types have reached their limitations and this period is remarkable for the number of new types which have been introduced, some of which have been developed to a considerable extent. The accompanying diagrams show graphically the progress which has been made with the various types of both freight and passenger, bituminous coal burning locomotives with respect to their total weight, weight on drivers, tractive power, heating surface and grate area, since 1895. This journal makes a practice of describing the most notable locomotives which are built from time to time and the data for the 62 passenger engines and the 65 freight engines, considered in the diagrams, is for bituminous coal burning locomotives which have been described in it. Each type is represented by a different symbol so that the progress made with the individual types may be traced.

PASSENGER LOCOMOTIVES.

The increase in the total weight and heating surface has been steady and uniform, the 8-wheel and 10-wheel types being succeeded by the Atlantic, Prairie and Pacific types. The increase in the weight on drivers and the tractive power, however, is not so marked. In the case of the Atlantic type the weight on drivers has gradually increased since its introduction and the same is true in a lesser degree of the tractive power. The tractive power of a few of the 10-wheel engines is quite high, but this is due to some extent to the small diameter of the driving wheels, which of course unfits them for the high speed work of the Prairie and Pacific types, which to a great extent superseded the 10-wheel type in passenger service. A comparison of the heating surface and grate area diagrams with that for the tractive power shows that they have increased at a faster rate than the tractive power, thus indicating that the more recent designs have a greater steaming capacity and are better fitted for sustained high speed. The advent of the

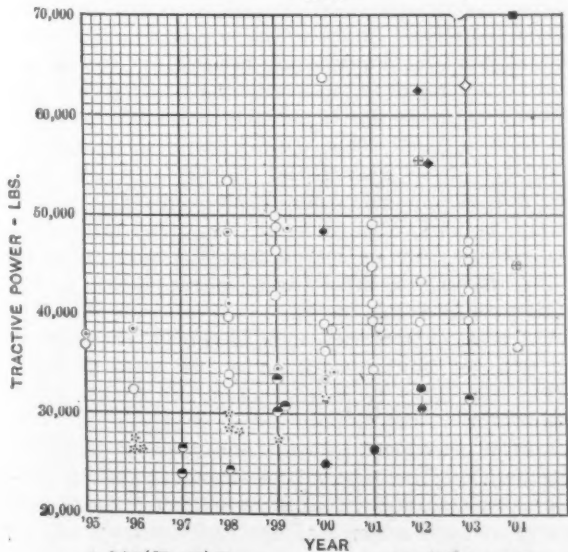
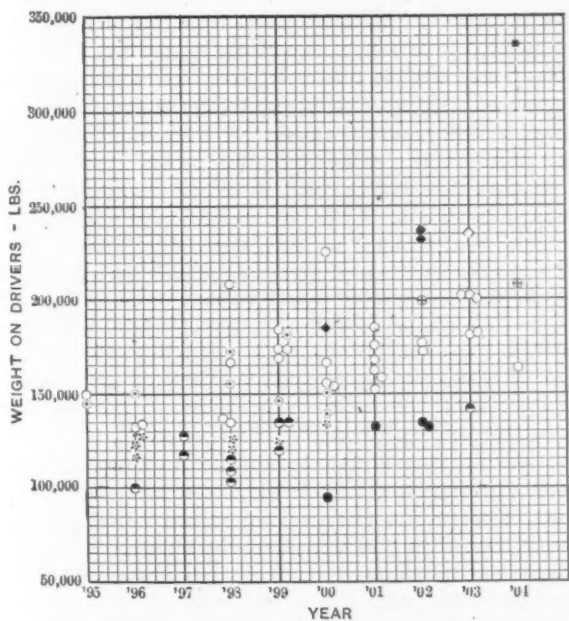
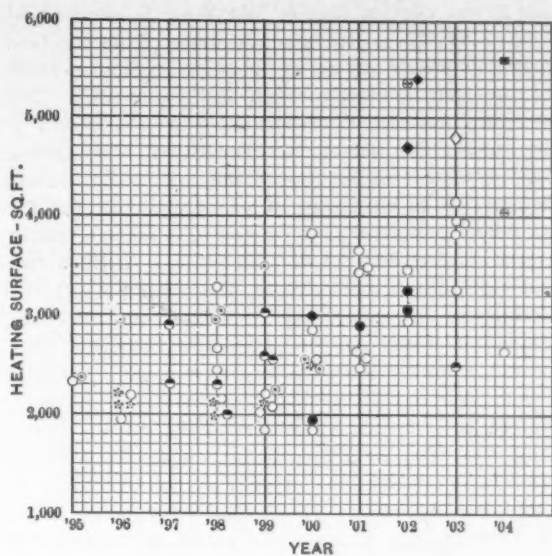


FREIGHT ENGINES.

wide firebox and its general adoption is indicated by the abrupt increase in the size of grate area beginning about 1901.

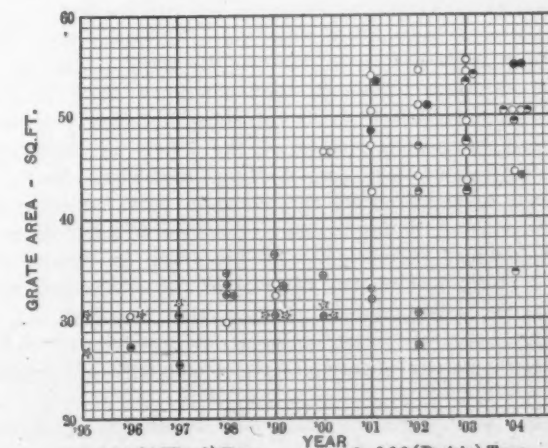
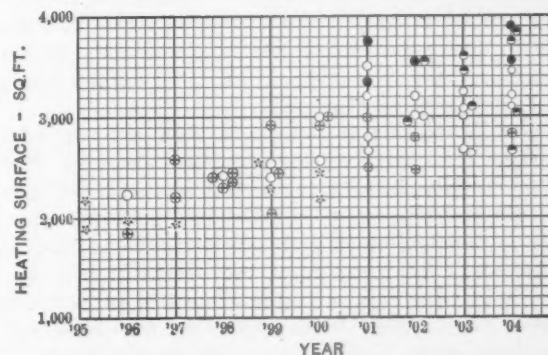
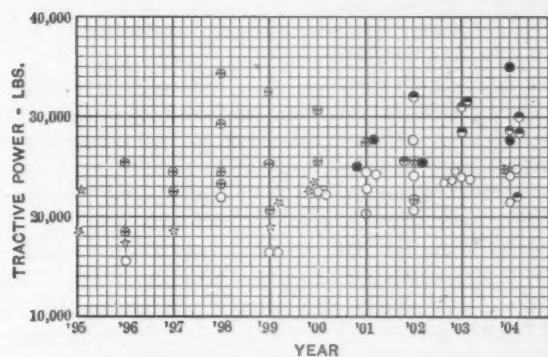
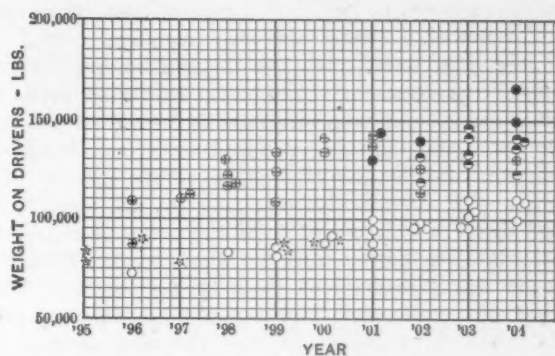
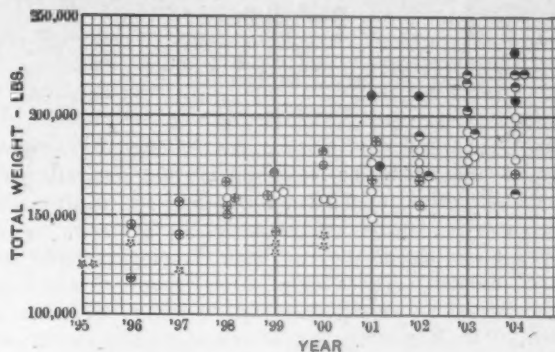
FREIGHT LOCOMOTIVES.

It will be found that as a rule the heavier and more powerful locomotives for each year were used on roads with very heavy grades, and the rapid increase in the total weight, weight on drivers, tractive power and heating surface of this class of locomotives is remarkable. This class includes the Mastodon type for the first two or three years shown; the two very heavy consolidation engines and Mikado, Decapod, Santa Fe and Mallet types. The lighter and less powerful freight locomotives used in ordinary service have also developed steadily in these respects. This may be seen by tracing the progress of the consolidation type. There is still a lighter class of freight locomotives, comprising some of the 10-wheel and the Prairie type, which is used for fast freight service, and the development of this class may also be traced on the diagrams. The abrupt increase in the grate area, which took place in 1900 and 1901, indicates the introduction and adoption of the wide firebox.



- * 2-6-0 (Mogul) Type
- 3-6-2 (Prairie) Type
- 4-6-0 (10 Wheel) Type
- 2-8-0 (Consol.) Type
- 2-8-2 (Mikado) Type
- 4-8-0 (Mastodon) Type
- 2-10-0 (Decapod) Type
- 2-10-2 (Sante Fe) Type
- 0-6-6-0 (Mallet) Type

FREIGHT ENGINES.



- * 4-4-0 (8 Wheel) Type
- 4-4-2 (Atlantic) Type
- 4-6-0 (10 Wheel) Type
- 2-6-2 (Prairie) Type
- 4-6-2 (Pacific) Type

PASSENGER ENGINES.

DESIGN OF STEEL CARS WITH REFERENCE TO REPAIRS.

BY A. STUCKL.

Simplicity in the design of cars is a fundamental principle, which at no time should be lost sight of, and generally speaking, if a construction is of a simple nature, i.e., if all complex arrangements of details are successfully avoided, we may look for a long life of the car with a comparatively small amount of repairs. There are limits, however, where simplicity, if carried to an extreme, will interfere with the ease of repair. For instance, details exposed to constant wear and tear are expected to last only a certain time, after which they are renewed. There are also members which are entirely free from wear, and if well designed never require any further consideration. Combining details of these two types into one piece would certainly be wrong in principle, although the design of the car would have been simplified.

Again, some details are exposed to severe strains, blows and shocks, while others, although near by, are exempt, and combining these two classes of details into one piece is again wrong in principle, inasmuch as the whole would either have to be made heavy throughout to meet the localized heavy strains, or else premature failure would be sure to follow. (By this I have principally reference to rolled sections and plates and not to castings, as the latter can be strengthened in those parts mostly exposed, so that the casting as a whole may be made of a uniform degree of safety.)

A good example of what has just been said is represented by the centre sills of the car. Between the body bolster and the end sill, they are subjected to the maximum blow coming on the car, while between the body bolsters this strain is more or less distributed. For this reason the portion between the body bolsters and the end sills, the draft sills, has often been made separate from the main centre sills, and, thus, it is possible to renew the member, which is bound to give first, very easily and without disturbing the main sills. It is good practice to extend the main sills through the body bolster and to unite the two by a sufficient number of rivets, but above all care should be taken that the portion of the main sills between the joint and the body bolster is braced or otherwise strengthened, so as to exclude the possibility of a failure at that point.

Often ease of repairs is coincident with ease of original construction. For instance, side and floor plates of gondola and hopper cars, if made in convenient sections, will greatly facilitate the building of the cars. The material is much more quickly handled, much more rapidly punched, and more easily assembled. In many cases the output of the shop is greatly reduced on account of being compelled to handle long and narrow centre floor sheets, extending from one end of the car to the other. Rack and multiple punches will, of course, overcome the trouble in punching, but the loss of time in handling and assembling remains. Naturally care must be exercised so as not to impair the strength of the car in the endeavor to facilitate the construction. This is especially true with reference to the car sides, but they are easily strengthened by proper splices at the joints of the sheets and by continuous top and bottom members. Such an arrangement of small sheets will come in very handy in the repair of the cars. If, for instance, the side of a car near its centre is damaged it will only be necessary to remove the damaged section, leaving the balance of the car intact, with the additional advantage of having the repaired car of exactly the same construction as it originally was, doing away with the patchy appearance often met with on repaired cars.

It is also very essential that each detail and each sub-construction be connected to the whole car in such a way, that it may be removed, whenever necessary, without disturbing the adjoining details. It is not sufficient to design, so that all these details can easily be erected in the car shop.

We must go one step further and see that these details do not interlock with each other, so that any detail, no matter whether it was applied first or last, may be removed with the same ease, whenever it becomes disabled in service. For this reason it seems wrong in principle to project some members of the body bolster through the center sills. This plan excludes the possibility of removing a center sill without actually taking the whole car apart, and, also, greatly complicates the matter of repairs to the body bolster itself.

Sometimes it is advisable to use one detail for fastening several other members. For instance, a corner bracket may serve as a support for the diagonal braces, a tie between the end and side sills, a backing for the push pole casting, and a fastening for the corner post, and it is evident that if this bracket should have to be renewed, all the other four members would likewise have to be disconnected, while, on the other hand, any one of these four members, if disabled, could be repaired or renewed without affecting all the other members, and it is clear that the bracket should be made stronger than the other component details, so as to reduce the liability of breaking. Many similar cases could be pointed out on the average car, and therefore the principle of making such combination details stronger than the adjoining members is that much more important.

As a rule, every rivet in the whole car should be accessible, even after the car is completed, and no design should be approved if there is not provision made for driving every rivet properly. In a pinch, the rivets have sometimes to be bent before they can be inserted; this should be avoided, if at all possible. Likewise countersunk rivets should be avoided, especially if they are covered over with other details, because it may become necessary to renew the piece fastened by the countersunk rivets, which would also mean a removal of the covering detail. There are exceptional cases where it is not likely that rivets ever will have to be disturbed, and therefore can be covered up by other details without hesitation. This mostly refers to flange angle rivets of the centre sills, which are often covered up with the hopper sheets. These rivets will not have to be disturbed unless the sills are damaged, and it is hardly possible that an accident could do this without also damaging the covering sheets, so that the above rule would not necessarily apply to these rivets.

The increasing competition in car building makes special machinery indispensable. Such machines not only save a great deal of labor and improve the accuracy and the finish of the work, but they also will turn out all details alike and interchangeable, which in itself is of great advantage. This holds true with the gang, rack and multiple punches, gang drill presses, pneumatic chipping tools, reamers and riveters, pit riveters, combined punches and riveters, bulldozers and presses, provided simple shapes are adhered to. But to be also beneficial in the repair of the cars, the work turned out by these special machines should be such that it can at any time be duplicated by hand. Often two or more simple pieces are made with one stroke in a special die. This is true economy and does not make repair difficult, as each single piece can, if necessary, be duplicated by hand. However, pressed pieces of intricate shape made on special dies will naturally be detrimental in this respect, unless each railroad keeps a certain number of these pieces in stock.

Speaking of stock material, it is of the utmost importance that the designer limit himself to as few sizes as possible. This refers principally to rolled shapes, and if this principle is carried out on all the different types of cars, a railroad can take care of all possible repair without carrying an unreasonably large amount of material. The same principle holds good in regard to castings, and if similar constructions for the different types of cars are adhered to, the same patterns can often be used over and over again. Great care should be taken so as not to make the castings of two opposite hands, if not absolutely necessary, and very often this can be avoided by an additional hole or other similar slight modification. It is true these additions are only used in half the cases, but the fact that half of the pattern work is saved thereby and that the

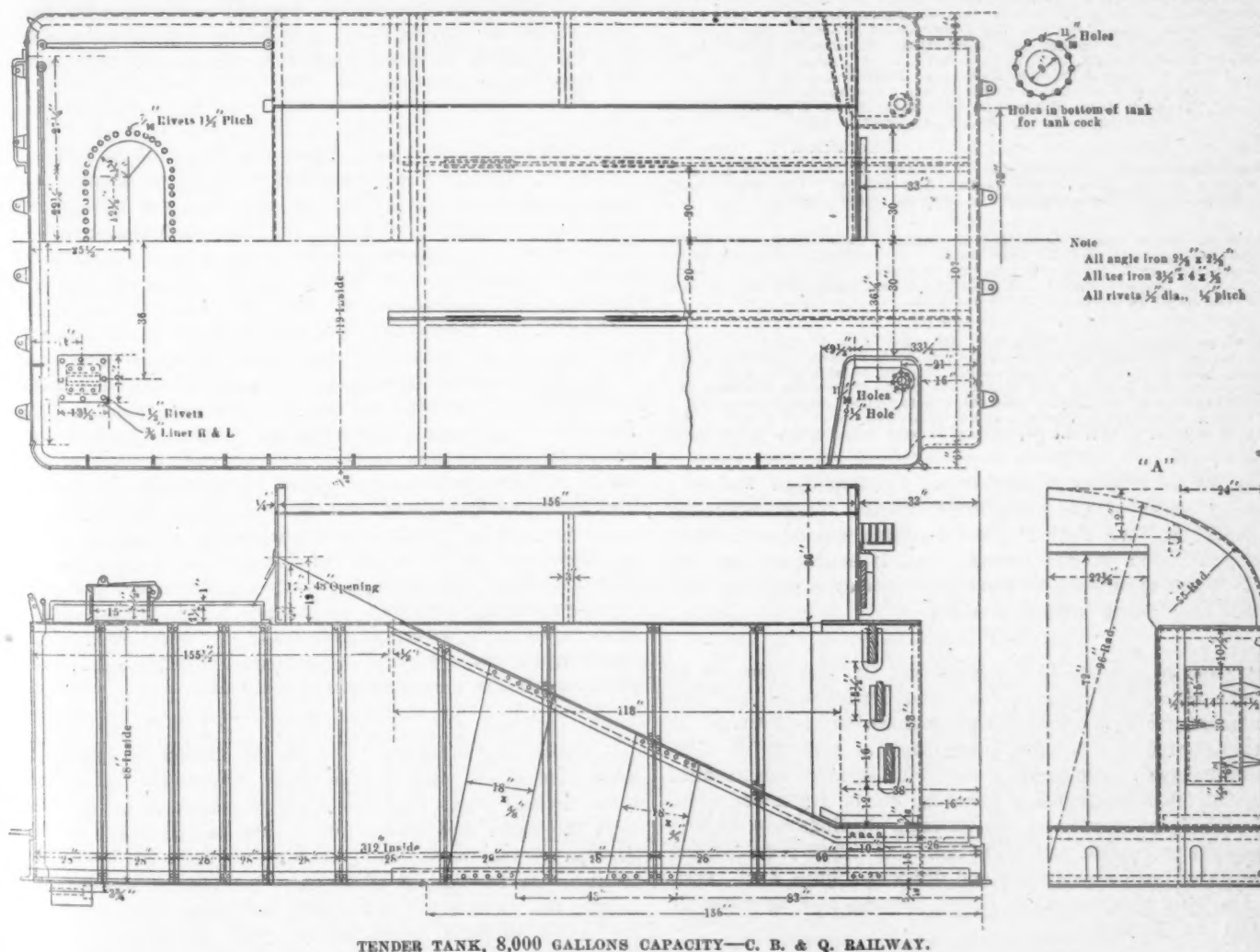
amount of stock castings is reduced will fully repay for such precautions.

To sum up, the following points should be carefully watched in order to facilitate the repair of steel cars:

1. Parts having wearing surfaces should be made removable.
2. Parts most likely to be damaged should be made removable.
3. Unwieldy large plates should be cut into smaller pieces, if consistent with the strength of the car.
4. Details should not interlock, but should be removable without disturbing the adjoining parts.
5. Combination details should be stronger than the parts fastened to them.
6. All rivets should be accessible after the car is finished.
7. The work done by the special machines should be of such a nature that it can be duplicated by hand, if necessary.
8. The number of patterns and the number of stock sizes in the rolled shapes should be kept as low as possible.

zontal distance of 24 ins. inside of the outer vertical face of the tank. At the front and back diaphragms connect these side hoods, permitting the coal to be carried high without the slightest danger of its falling out. These tanks have a water bottom under the firemen's feet, to which all the coal in the coal space is brought by gravity. This design also includes a coal gate of four planks 10 ins. wide, fitted in sockets, as noted in the drawing. When not in use these are carried in other sockets, keeping them up out of the way. Reports of the service of these tenders indicate that they are very satisfactory. This design has been used on a large number of locomotives, and the loss of coal from tenders while on the road is entirely eliminated.

WRITING ON BLUEPRINTS.—A solution of carbonate of soda or caustic soda, frequently recommended for the purpose, is not nearly so good as one of potassium oxalate. The uniform strength of solution is important, though why a variation in the strength of such a neutral substance as potassium oxalate



TENDER—8,000 GALLONS CAPACITY.

CHICAGO, BURLINGTON & QUINCY RAILWAY.

The class R-4 Pacific type locomotive of the Chicago, Burlington & Quincy was illustrated in this journal in September, 1904. The photograph which appeared at that time showed the exterior of the tender, which has a capacity of 8,000 gals. of water and 16 tons of coal. The longitudinal section of the tank shows the method of bracing, the slope of the inclined floor of the coal space and the arrangement of hoods carried up at the sides of the coal space to prevent the coal from falling off. The drawings show the form of these hood plates, which terminate at points "A" at a hori-

should make any difference I am unable to say. However, 75 grains dissolved in an ounce of water will remove the blue ground of the drawing in a few seconds; it can be applied with a pen or fine brush, the solution, if necessary, being thickened with gum. The paper should be well washed afterward, for if this is not done the blue color is very likely to reappear. Engineers who use this method on large tracings frequently content themselves with mopping off the surplus solution with blotting paper and "washing" the treated part by applying wet blotting paper once or twice. This imperfect method of removing the chemicals is, no doubt, responsible for the complaint made in many engineering shops that details written in this way gradually disappear from the drawing, the blue ground being gradually restored.—Photo-American.

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Advertisements.—Nothing will be inserted in this journal for pay, EXCEPT IN THE ADVERTISING PAGES. The reading pages will contain only such matter as we consider of interest to our readers.

Contributions.—Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.

To Subscribers.—The AMERICAN ENGINEER AND RAILROAD JOURNAL is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied. When a subscriber changes his address he ought to notify this office at once, so that the paper may be sent to the proper destination.

As we go to press the indications are that there will be a general strike of the compositors of New York City after January 1st. We do not expect that this will interfere with the publication of our journal; but, if so, would ask our readers and advertisers to overlook any delay or shortcomings which may result from this cause.

It gives us pleasure to announce that Mr. E. A. Averill has become associated with our editorial department. He was graduated from the mechanical engineering department of Cornell University in 1900, specializing in railroad work in his senior year. The summer of 1899 he spent in the Reading shops of the Philadelphia & Reading, and in September, 1900, he entered the service of the Chicago, Burlington & Quincy as special apprentice, and spent three and a half years in this capacity at LaCrosse, Aurora and Chicago. Since April, 1904, he has been associate editor of the Railway and Engineering Review, at Chicago.

"Piecework inspector" is usually the title of the man who exercises the important function of introducing and establishing piecework in railroad shops. This is an unfortunate name; why not call him something else? It is not considered quite the thing to appoint a policeman to greet one's friends at a reception, although it is perhaps well to have one at hand, but in the background. Much depends upon who the friends are. Would it not be better to place piecework in charge of a man whose chief qualification is his knowledge of the work to be done, and whose chief duty is to use this knowledge in every possible way to help the workmen to realize the benefits of piecework? The opinion of a newspaper may not be very valuable in this matter, but it can do no harm to observe that many people do not start piecework upon the foundation of a study of human nature. When piecework

is once started on a correct basis of prices the next thing to be done is to show the men how they can make the highest wages. "Inspectors" cannot do this.

Not to know what you are buying is sometimes excusable, but not to know what you are selling is unpardonable. A shop superintendent in charge of one of the largest and most up-to-date railroad shops told the writer that he recently needed a machine for making a certain part of which large numbers were used. In consultation with the machine tool manufacturers looking to the purchase of a machine which would turn them out at the minimum expense, he was urged to buy a certain machine because the manufacturers guaranteed it to make 75 of the pieces in ten hours. This being the best guarantee offered, the machine was installed. The manufacturer had put on his best man to make the 75 pieces and expected to be asked to loan the man to show the railroad shop people how to get the maximum output from the machine. In fact, the offer of the man was made to the purchaser. When the machine was put into service the job was turned over to a bright young man in the railroad shop, who was not told how much work was expected of him. He turned out 250 pieces the first day.

In visiting the mechanical department of one of the leading American railroads the Editor had occasion to consult the back numbers of this journal for 1903, and the mechanical engineer sent a boy for the file. He returned, bringing ten of the worst-looking papers possible to imagine. They were thumbed and soiled, and were practically worn-out, but by legitimate use and not abuse. The ten numbers, containing articles on the Collinwood shops, showed this hard service, and on inquiring the reason it was found that every plan and detail of these shops had been carefully studied and considered in connection with new plans of the shop plant, which the road in question has worked up. This is significant of the importance of shop installations, and such a study of existing construction means much for the railroads. It is beginning to be appreciated that railroad shops, which are to stand for perhaps thirty or forty years as a monument of the intelligence of the designers, must involve an expenditure of from one to two million dollars. This constitutes a problem to be considered seriously. It is easy to recall days when shops were built without much study or consultation with anybody, and the difference in facilities and efficiency of the two methods are now everywhere recognized.

It seems fair to assume that in the process of handling locomotive boiler flues in the shop, considering the same steps through which the flues must pass after their removal from the boiler and up to their return to the boiler again, the cost of the work should be fairly uniform all over the country. As the cost of labor varies in different sections, of course, the expense of this work will vary somewhat, but the actual variation in prices paid for this work in the various shops of one road and in the shops of different roads is out of all proportion to the varying prices for labor. While flue work does not involve a great expense proportionately to the total cost of locomotive repairs it is one of the steady expenses which mounts up year by year. In a casual examination of figures received from a number of roads prices of 3.5, 3.75, 3.45, 3.82 cents have been noted. A number of other shops do this work at a cost of 4 cents. These figures include transportation of the flues, cleaning, cutting off the safe ends, scarfing, attaching, welding and testing. In many other shops the figures run very much higher. As this work, handled in the best possible manner, does not involve expensive machinery those whose prices run much higher than these will find it worth while to look into the subject with a view of securing the best possible furnaces, the best arrangement of the furnaces and machinery, and the provision of inclined

planes, or horses, or perhaps racks in order to cut down the expense to the proper figure. It is an interesting fact that the shop which has the best arrangement for handling flues is very often likely to be well managed in other respects, because good shop management is very conspicuous and the lack of it equally conspicuous in the flue work where deficiencies cannot be hidden. For this reason shop superintendents may profitably give this department considerable thought.

HEAVY PASSENGER CARS.

The matter of the weights of passenger cars is emphasized by the recent acceleration of long-distance trains between New York and Chicago. It may be necessary to build for this service the very heavy cars of the present time with trucks weighing as much as the whole car ought to weigh, but it certainly seems reasonable to believe that the weights may be materially reduced by the use of steel construction in the framing of such equipment. No one can tell what the future is to bring forth in the way of the development of the locomotive, but there is reason to believe that weights on individual driving wheels have reached the safe limit of the present rails. Whatever the balanced compound may accomplish in the matter of reducing the variation of pressure between the wheels and the rail, the static weights themselves have reached a point beyond which it seems to be unwise to proceed. This limit once reached does not mean that finality in locomotive development has been attained, and consolidation or even decapod locomotives may yet be used to haul passenger trains. This seems on its face to be an absurd suggestion, but it is not as absurd as it seems, when passenger trains on a large number of roads have reached the weight of 600 tons in ordinary service. There will undoubtedly be great opposition against the lightening of cars, but, nevertheless, this is the direction in which the railroads will be forced to go in order to find the relief which is becoming necessary. This relief may perhaps not be as difficult as it seems at the present time, because as yet practically nothing has been done towards the introduction of steel construction into long-distance passenger equipment.

On the whole, it seems strange that more progress has not been made in such a promising field, and there seems to be no question that this is not only probable, but a necessary direction for the efforts of the designers to-day. The American traveler will not be deprived of his comforts and luxuries. Five thousand, one hundred and eighty pounds per passenger is a very expensive proportion from the standpoint of the railroads. The car designer has an attractive problem, though a difficult one, in designing his car, with the luxuries as a basis, and making the structure of metal and lighter than the structures of present practice.

MILD EXHAUST.

A high official of an American railroad who has just returned from abroad was particularly impressed with the very mild exhaust of foreign locomotives, particularly in France, and inquired the reason.

The soft exhaust of French locomotives is noteworthy. Without doubt much is due to the use of variable exhaust nozzles and the absence of diaphragm plates in the smoke-boxes. The methods employed by French and English railways permit of giving to each class of new locomotive as it is introduced upon the road most careful attention as to the adjustment of the front end appliances. New designs of locomotives are not introduced so frequently as to become the common affair which it has become in this country. Each new design receives the personal attention of the motive power official in such a way that the first example of the new class is made perfect as to the adjustment of its front ends before others are built. Such methods enable foreign loco-

motive men to avoid the use of the diaphragm plate, which Dr. Goss showed in the AMERICAN ENGINEER tests to be responsible for one-third of the work of the exhaust jet. Variable exhaust nozzles have been repeatedly tried in American practice, but this device has never become a part of our common practice. The principle reason for this is the difficulty in training American engineers to use such a device properly. They do not even use the starting valve of compounds properly, for one need not go very far to find compound starting valves left open during an entire run.

It is different in France where the locomotive engineers are working under a system of premiums, which involve questions of fuel consumption, of punctuality and of otherwise satisfactory service. French locomotive engineers are safely trusted with variable exhaust devices, and they use them and use them properly. In starting out from a station the nozzle is enlarged to save tearing the fire and on the run the nozzle is adjusted to suit the conditions. In case the steam pressure runs down it may usually be quickly restored with the nozzle, but if the nozzle is thus restricted it is done so with care because of its effect upon the earnings of the men at the end of the month, through the consumption of more coal. There is a long history back of the good work of the French locomotive engineers, and one which would make a profitable study for those who appreciate the soft exhaust of their locomotives.

THREE YOUNG COLLEGE MEN.

A short time ago, within three days, three young men of fine appearance called on the editor of this journal to tell about their troubles, which led them to leave railroad service. They came at different times, from different parts of the country, and related widely different experiences.

All had been special apprentices, they had been in the service five, six and nine years, respectively, and all three had risen to the position of roundhouse foreman. The first had received ninety, the second one hundred, and the third one hundred and forty dollars a month, indicating that they were able young men, performing acceptable service.

Each had voluntarily "quit," to accept apparently more promising positions, and this strange coincidence of three promising, fine young men becoming switched from a career which they had followed faithfully for an important period of time, should set railroad officials thinking.

All these young men told the same story, that of no opportunity and of a long line of superiors in excellent health.

The young men were attracted elsewhere by more money and less "grief," for if there is any position to more sorely try men's souls than that of presiding over a roundhouse it has not yet been named. This experience entitles the railroads and also the young men to a word of advice. If a roundhouse is successfully managed by any one, old or young, there is scarcely an administrative task about a railroad too great for that man to solve. If a young man has handled a roundhouse properly, the officials of the railroad who are responsible for letting him escape should be called to account by the owners.

Any technical school graduate, or, for that matter, any undergraduate of the school of hard knocks, who has attained to the successful management of a roundhouse, is foolish to leave it for any outside position, no matter how immediately attractive, for the successful roundhouse foreman has all the elements required of a general manager, and if he sticks to his task nothing can hold him back, not even the longest line of healthy superiors.

The young men perhaps need more patience. Their reward is certain. The railroads need to lose a great many more good men in order to understand the serious consequences of their neglect of the underlying principles of organization. Transportation interests are so great as to be sure to make this matter right some day.

WALSCHAERT VALVE GEAR.*

BY MR. CARL J. MELLIN.

GENERAL DESCRIPTION.

The motion of the valve is derived both from the crosshead and the eccentric crank, from a driving axle. The crosshead connection imparts the lap and lead at the extremities of the stroke, when the eccentric crank is in its middle position. The eccentric crank in this position imparts its fastest movement to the valve to give a very quick opening. The crosshead motion in advancing from the dead point effects an approximate uniformity in the combined motion given to the valve as if it was derived from a single crank or eccentric set with an angle of advance corresponding to the lap and lead. The valve motion may therefore be graphically illustrated in the same manner as that of the Stephenson motion, with a circle representing the path of the eccentric, the diameter of which is equal to the travel of the valve, and the valve events may be determined in the same way by any of the well-known methods of Professor Zeuner and others, as illustrated. It will be observed that the only apparent variation due to this gear is that brought about by the invariable lead.

The Walschaert motion, as usually constructed, does not lend itself as freely to adjustment as does the Stephenson motion with independent eccentrics, and for this reason it is not as liable to get out of adjustment. It must be correctly laid out in the design and correctly fitted up. The importance of this cannot be overestimated. The various points must be carefully plotted in order to give the best results in the combination movement of the parts of the motion. The movements of the motion involve such complications in plotting as to render the complete plotting of all too laborious for every new design, and for this reason the use of an adjustable model is very desirable in designing this gear. However, with complete knowledge of the nature of the gear, simple methods and formulæ may be used to determine the locations of the various points covering the motion. One object of this description is to avoid the necessity of a model except to verify the results.

To entirely overcome the irregularities inherent in all motions transformed from circular into lineal, cannot for practical reasons be expected, but the errors may be reduced to such an extent that they do not affect either the power or economy of the locomotive. This remark is made to forestall the inference that the accuracy of the Walschaert motion as to the cut-off points is not superior to the Stephenson motion when the latter is turned out of the shop.

In the construction of the Walschaert gear the desired travel of the valve, the lead and the maximum cut-off which determines the lap of the valve, are selected. The stroke of the piston being given, the combination lever is proportioned so that a motion equal to the lap and lead is given to the valve when the crosshead is moved from one end of the stroke to the other. The link may be made of any approved design, and is so located that the radius bar will have a length of at least eight times (ten or twelve times is better) the travel of the link block, and the radius of the link should be equal to the length of the radius bar.

For outside admission valves the radius bar is attached to the combination lever between the valve stem and the crosshead connections, and for inside admission (piston valves) it is attached above the valve stem. The fulcrum of the link should lie as nearly as practicable upon a line drawn through the union of the radius bar and combination lever, parallel with the center line of the valve stem. The suspension point of the lifter should have a locus which causes the link block to travel as nearly as practicable on a chord of the arc described by any point of the link wherever the block happens to be when the link is swung into one of its extreme positions. This is most closely approached by a

lifter through which the radius bar slides, and does not swing with the link. A properly suspended hanger will accomplish practically the same result, though the slip of the link bar will be somewhat more in the back than in the forward motion, but as the suspension point cannot be made to follow the theoretical locus, it should be made to do so as nearly as possible by favoring the position of the most commonly used cut-offs. In locating the longitudinal position of the link fulcrum, consideration should also be given to the length of the eccentric rod, which should have a minimum length of three and one-half times the eccentric throw, and should be made as long as circumstances will permit, with an approximately equal length of the radius and eccentric rods. The point of connection between the eccentric rod and the link should be as near the center line of motion of the main rod as this correction for rod angularities will permit, but this is often accompanied with the requirement of excessive eccentric throw. In such cases a compromise must be made to raise this point. The fore and aft position of this point relative to the tangent of the link arc must also be determined with reference to the angularity of the eccentric and main rods, so that the link is exactly in its central position when the piston is at either end of the stroke. The angles through which the link swings on both sides of its central position should be as nearly as practicable equal, but this is subordinate to other conditions. Attention should be paid to the effect of the angularity of the main connecting rod upon the cut-off, to reduce this to a minimum, this having an effect upon determining the locus of the suspension point of the lifting link as well as that of the eccentric rod connection to the link.

It is evident that a proper design of Walschaert gear can only be laid out by a skilled draughtsman. In maintenance care is required that all parts should preserve their original forms and positions, and this should be checked by verifying the valve events through turning the main driving wheels before the locomotive goes into service.

The chief point of difference between the Walschaert and Stephenson motions is that the former gives to the valve a constant lead at all cut-offs, whereas the latter produces an increase of lead which becomes excessive at short cut-offs.

METHOD OF ADJUSTING VALVES WITH WALSCHAERT GEAR.

The lap and lead are determined by the proportion of the arms of the combination lever and the stroke of the piston. The amount is found by turning the engine from one dead center to the other center in any cut-off position.

1. The motion must be adjusted with the cranks on the dead centers by lengthening or shortening the eccentric rods until the link takes such a position as to impart no motion to the valve when the link block is moved from its extreme forward to its extreme backward position. Before this change in the eccentric rod is resorted to, the length of the valve stem should be examined, as it may be of advantage to plane off, or line under, the foot of the link support which might correct the lengths of both rods, or at least only one of these should need to be changed.

2. The difference between the two positions of the valve on the forward and back centers is the lap and lead doubled and cannot be changed except by changing the leverage relations of the combination lever.

3. A given lead determines the lap, or a given lap determines the lead, and it must be divided for both ends as desired by lengthening or shortening the valve spindle.

4. Within certain limits this adjustment may be made by shortening or lengthening the radius bar, but it is desirable to keep the length of this bar equal to the radius of the links, in order to meet the requirements of the first condition.

5. The lead may be increased by reducing the lap, and the cut-off point will then be slightly advanced. Increasing the lap introduces the opposite effect on the cut-off. With good judgment these quantities may be varied to offset their irregularities inherent in transforming rotary into lineal motions.

*From an American Locomotive Company pamphlet.

6. Slight variations may be made in the cut-off points as covered by the previous paragraph, but an independent adjustment cannot be made except by shifting the location of the suspension point, which is preferably determined by a model.

METHOD OF LAYING-OUT WALSCHAERT GEAR.

Having presented a general outline of the gear, we may proceed in determining the more important points necessary to obtain a successful motion of the valve, and, as previously stated, the stroke of the engine is given, and the travel and lap and lead of the valve are selected to suit a desired cut-off. We have first to find the proportions of the combination lever. By designating the lap and lead with the letter c , the crank radius with R , the crosshead end of the combination lever with L , and the valve end of same with V , we have $R : c = cL$

$L : V$ or $V = -$, with the connection F of the radius bar as a fulcrum. The length of the combination lever must be determined from the height of the valve stem over the piston

limiting the angle of the swing of the link to a maximum of forty-five degrees, we get the raise or depression of the radius bar and link block $Og = \frac{b}{\tan. d}$, where O is the link

fulcrum and $d =$ half the angle of swing of the link.

The location of the link and eccentric rod connecting point K cannot be determined with any practicable formula, but must, as already stated, be found by plotting to meet the requirements of the different cut-offs and corresponding crank positions. The same is also the case with determining the locus for the suspension point P of the lifting link, and in these two locations lies the principal success of the gear.

REULEAUX AND ZEUNER DIAGRAMS.

Figure 4 shows a combination of two diagrams; namely, those of Reuleaux and Zeuner, which coincide exactly as to the different valve events, which may be found as follows:

The distance AB represents the travel of the valve as well as the stroke of the engine, though in different scales, which makes no difference when the cut-off is always ex-

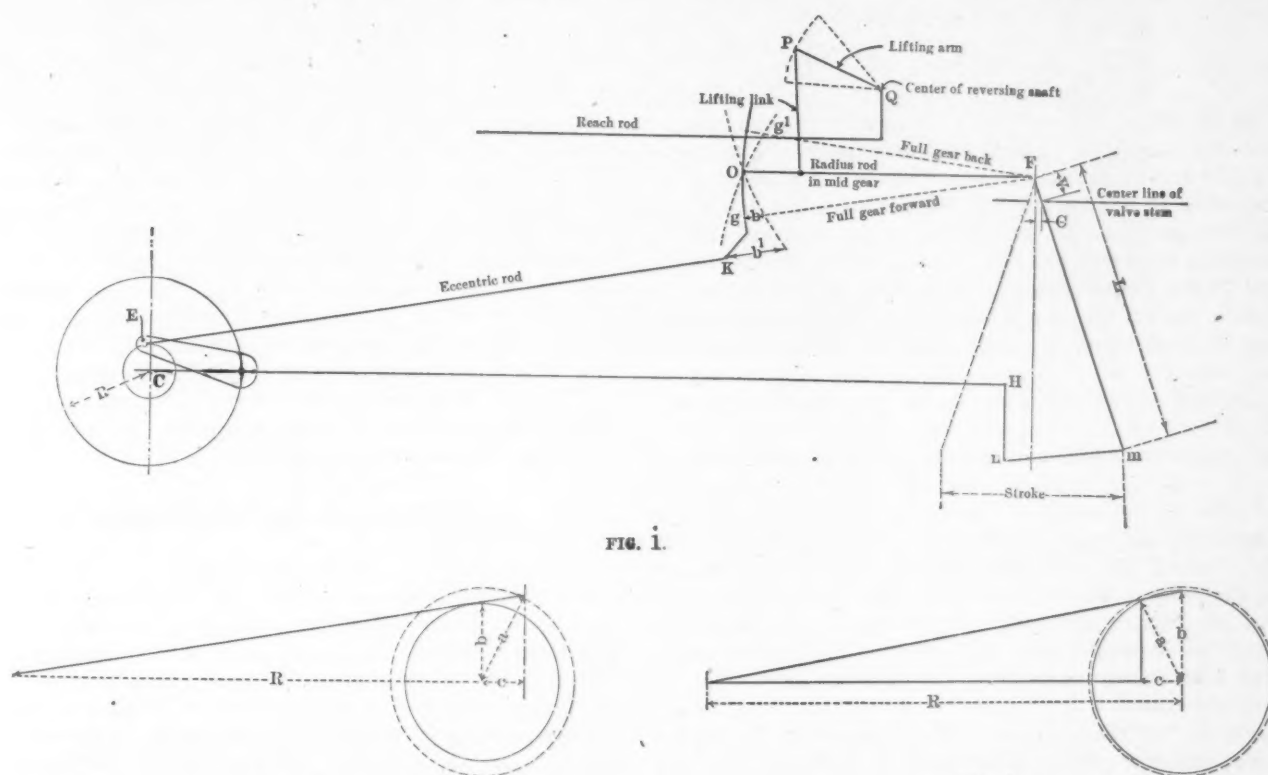


FIG. 1.

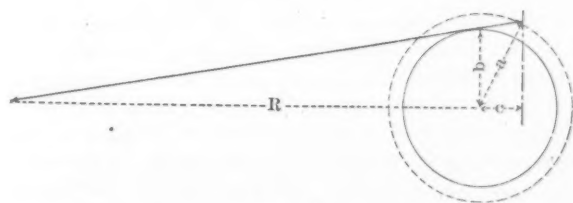


FIG. 2.

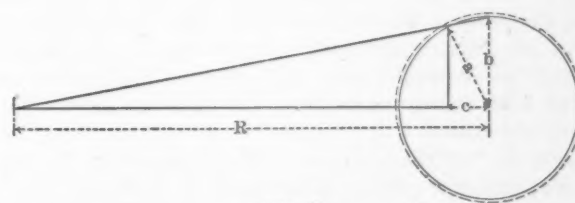


FIG. 3.

rod and a convenient angle of oscillation of forty-five to fifty, which should not exceed sixty, degrees.

We have next to find the required travel of point F , Fig. 1, to obtain the desired valve travel which we, for convenience sake, take on one side of the center position, or half its total travel in full gear, and which we will designate b , when we have

$$b = \frac{R \sqrt{a^2 - c^2}}{R + c} \text{ for outside admission, and}$$

$$b = \frac{R \sqrt{a^2 - c^2}}{R - c} \text{ for inside admission valves,}$$

where a is the radius of an eccentric that would give the required travel of the valve, and c is as given above.

This may be laid out graphically as in Figs. 2 and 3, when a is equal to one-half the travel of the valve and R and c the same as in the above formulæ.

With the limited amount it is advisable to allow in raising and lowering the link block in reversing the motion, we can without practical error consider the half movement of the link block g to be the same as that of point F , and by

pressed in fractions or per cent. of AB . The maximum cut-off is determined upon to be AR . Draw a perpendicular line RC from AB until it cuts the arc ACB . Next decide on a desired lead and, with that as a radius, draw an arc with A as a center. Draw a line from C tangent to the lead circle around A , when the lap of the valve is found to be equal to the perpendicular distance from the line CS to the center O of the diagram. The crank will then be in position OS when the valve commences to open or the angle AOS in advance of the dead center and on OC at cut-off. Continuing, we find the valve in its middle position when the crank is on OG which is drawn parallel to SC through the center O . Extend this line to F , and with the exhaust lap as a radius draw the exhaust lap circle on the opposite side of the line GF and draw DE tangent to this circle, when OD is the position of the crank at the release point. From this point the exhaust remains open until the crank reaches the position OE , when it closes and compression takes place until it again reaches OS for admission and one revolution is completed.

By placing the Zeuner diagram upon this, draw HJ perpendicular to FG , and with the radius OH of the eccentric circle as a diameter, draw the admission valve circle $OVHnO$.

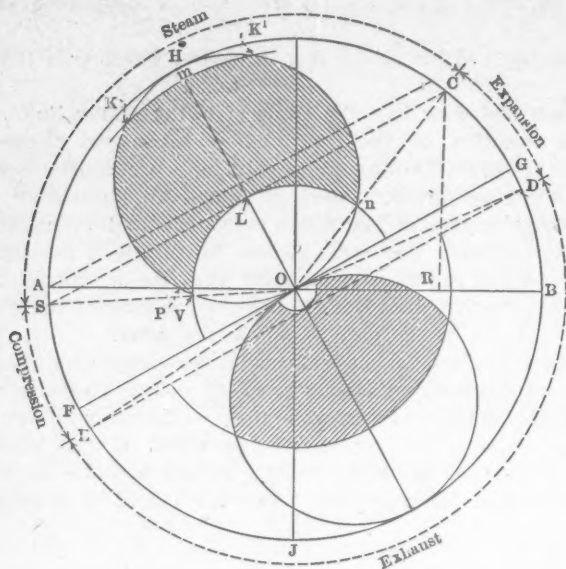


FIG. 4.

and the lap circle with the steam lap as a radius and find the intersection occurs at V, both with the circles and the previously laid down admission line OS and the cut-off point at the intersections at n. On the line OH set off the width of the steam port from L toward H equal to Lm and with Om as radius draw the arc KmK. The shaded figure enclosed by the letters VKK'nL represents the steam port opening during the admission period and the width of the port opening at any desired position of the crank is found by measuring the distance radially from O between the lap and valve circles on the port line, as the case may be, on the desired crank position.

The exhaust openings are determined in the same manner and are shown on opposite side of FG, where the crank passes through the arc DJE during the exhaust period with a positive exhaust lap of the size EF. When the exhaust edge of the valve is line and line this arc becomes GJF or 180 degs., and when a negative lap (clearance) occurs, the duration of the exhaust period exceeds the half revolution of the crank. The various events are indicated around the eccentric circle on the figure as they take place during a complete turn of the crank.

In Fig. 5 the eccentric and admission valve circles are shown at different cut-offs where each set of lines and circles is governed by the same explanation as those of Fig. 4, where the admission points S, S¹, S², S³ correspond to the closing positions C, C¹, C², C³, cut-off points R, R¹, R², R³, etc. On OH we have the full travel valve circle and OL the lap or radius of the lap circle, the latter being the same for all cut-offs as well as the lead, the radii H¹, H², H³, etc., of the eccentric circles or diameters of the corresponding valve circles terminate on a line HI drawn perpendicular to AB and at a distance from O equal to that of lap and lead.

When the reverse lever is in its center position the diameter of the valve circle falls on the line AB and is equal to lap and lead. Continuing in back position we have the same method repeated and OI would be the full travel valve circle diameter, or the same as the eccentric radius for the valve travel. Any desired cut-off position may be laid out in same manner as that in Fig. 4, which shows all the valve events for a complete revolution of the axle.

The movements are in actual practice not so regular as the circles indicate, as it is impracticable to obtain the various loci in their theoretical positions; besides we have the angularities both of the main rods and the eccentric rods to contend with and whereby irregularities are entering in the problem that must be compensated for, as referred to in the general description. It is not to be considered that a uniform circular motion is the best, but an approximation

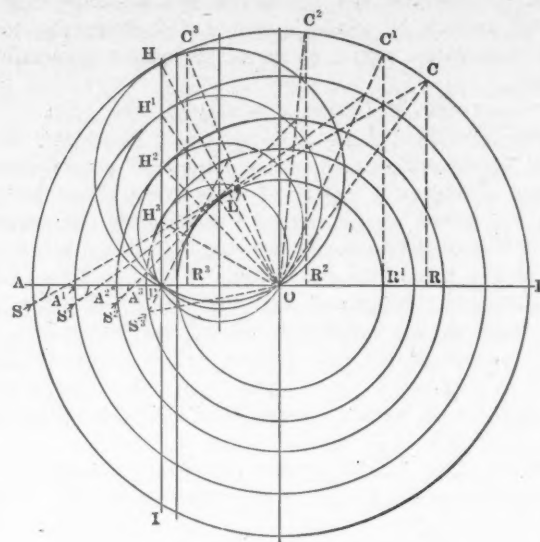


FIG. 5.

to it works with less shocks or jerks, and is therefore more desirable for so high speed an engine as a locomotive. A few advantages can be taken, however, in selecting the suspensions and various connections, so that better results can be obtained than from a true circular motion, which are principally affected by three union points and are, first, the connecting point of eccentric rod and link; second, the locus of the lifting link suspension point; and third, the relative height of the crosshead connection point of the union bar to the corresponding point of the combination lever.

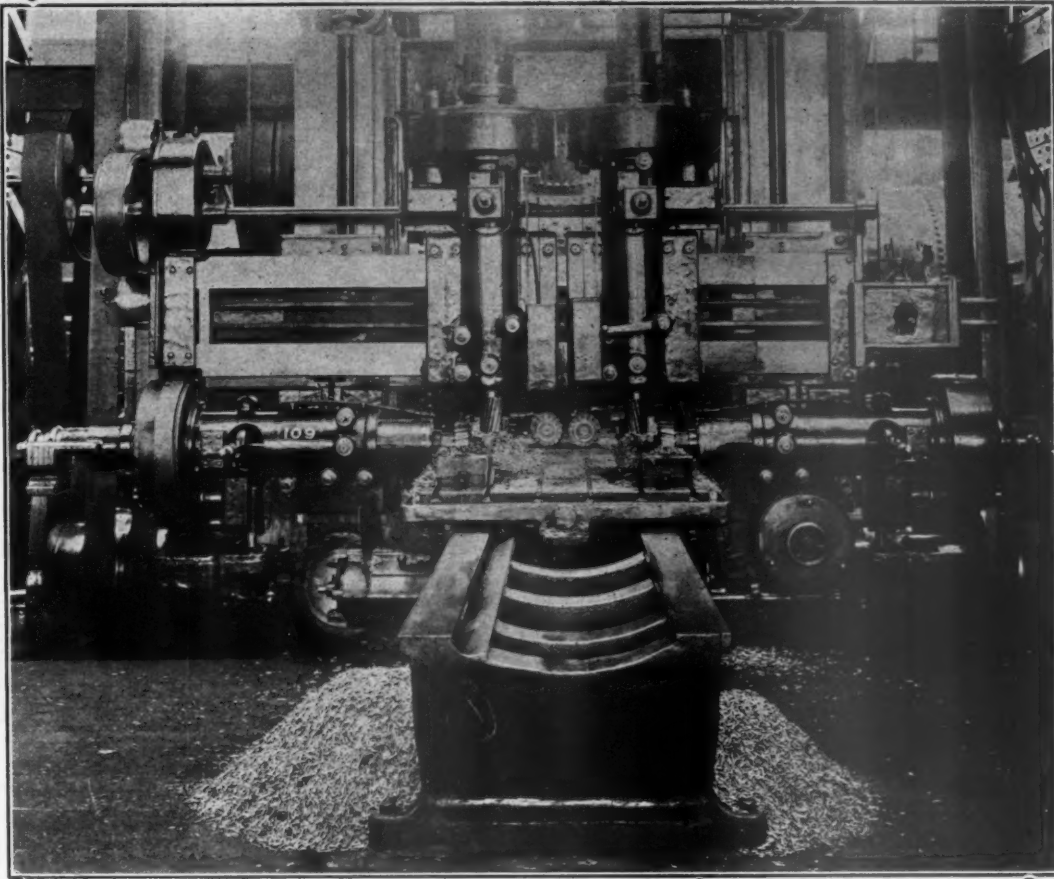
It is not necessary to lay out the valve diagrams except where a given cut-off per cent. is wanted. This is the most convenient way to find the required lap.

PRODUCTION IMPROVEMENTS.

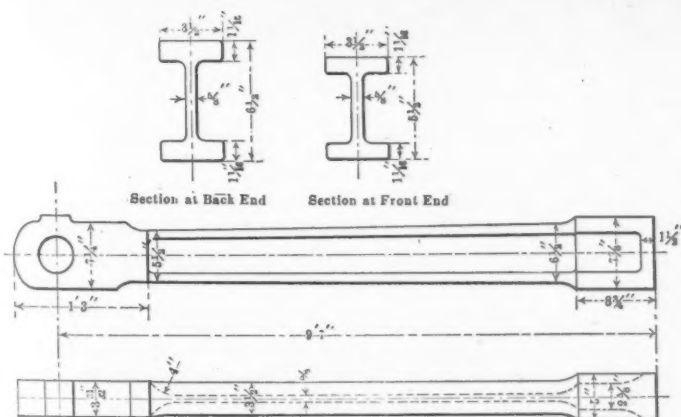
MILLING SIDE RODS.

The illustration shows a 5 by 5 by 12 ft. Ingersoll milling machine milling a set of main rods for the class D-11 ten-wheel locomotives at the Angus shops of the Canadian Pacific Railway. One of these main rods as it comes from the blacksmith shop weighs 1,009 lbs., and after it is removed from the milling machine its weight is 539 lbs., or in other words, 470 lbs. of metal are removed from each rod or 940 lbs. per set. By means of the side and vertical heads the bodies of these rods are paneled and the tops of the flanges, the sides of the rods and the flats of both the front and back stub ends are milled so that the only additional work to be done is the finishing of the sides and ends of the stub ends and the drilling. The sides of the rods are milled by the vertical head cutters. The panel is milled by the side head cutters, as shown in the illustration and the tops of the flanges of the panels and the flats of the stub ends are milled by the side head cutters shown laying on the table, which replace those used for milling the panels. The bottom and both sides of the rods shown on the machine have been finished and the pile of chips on the floor shows the amount of material removed from the rods before they were turned over. The panels are milled by an inserted plate type cutter 8 ins. in diameter and 3 1/4 ins. wide, operating at a speed of 25 r.p.m. with a table feed of 1 5/8 ins. per min. The body of the rod as well as the panel is tapered, and it is necessary to set one side of the rod straight and mill the panel, and then mill the straight side with the vertical head cutter. The rod is then set over to get the other side straight, and the panel is completed and the vertical head finishes the side. The top of the rod is then finished.

The main rods for switch engines, class U-3-C, are not quite as heavy as the rods for class D-11, and as the panels are not



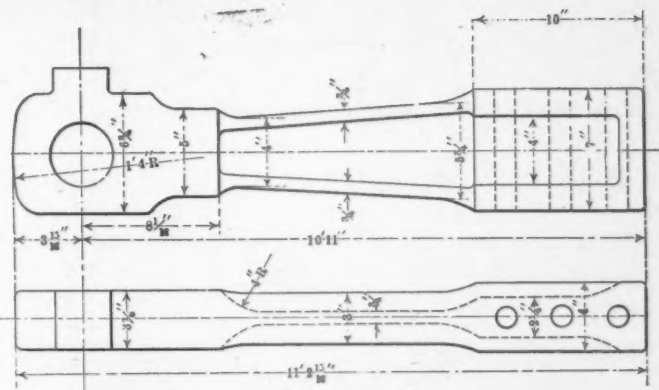
MILLING CONNECTING RODS ON INGERSOLL MILLING MACHINE AT THE ANGUS SHOPS.



CONNECTING ROD FOR CLASS D-11 ENGINES.

as wide or deep the method of handling these rods varies somewhat from that above. These rods as they come from the blacksmith shop weigh 822 lbs. each, and after they are milled weigh only 416 lbs., or the machine removes 406 lbs. of metal from each rod, or 812 lbs. per pair. As the panel is considerably smaller than for the D-11 rods, it is possible to work both the vertical and horizontal cutters at the same time, although they are operated at a lower feed than that used on the D-11 rods. These vertical cutters are solid, 4 ins. in diameter and 6 ins. long. They are set ahead of the side cutters, and as soon as they have worked far enough ahead the panel cutters in the horizontal heads, which are of the inserted plate type 8 ins. in diameter and $2\frac{1}{4}$ ins. wide, are set to work operating at a speed of 25 r.p.m. With the four cutters at work the table speed is reduced to $1\frac{1}{4}$ ins. per min. When near the ends of the rods the vertical cutters are raised up out of the way and the side head cutters finish to the end of the panel.

To finish the panels on the two sides of the rod and mill both sides of the D-11 rods, the table is fed six times, and a heavy feed is used for the panels; while with the U-3-C



CONNECTING ROD FOR CLASS U-3-C ENGINES.

rods the same work is done and the table is fed only four times, although a lighter feed is used for panelling. Side rods are also milled on this machine and with less setting, as they are straight in both the body and the panel. The machine is belt-driven and it is aimed to keep it running at its full capacity just as large a proportion of the time as it is possible.

EXPANDING CHUCK FOR TRUCK WHEEL TIRES.

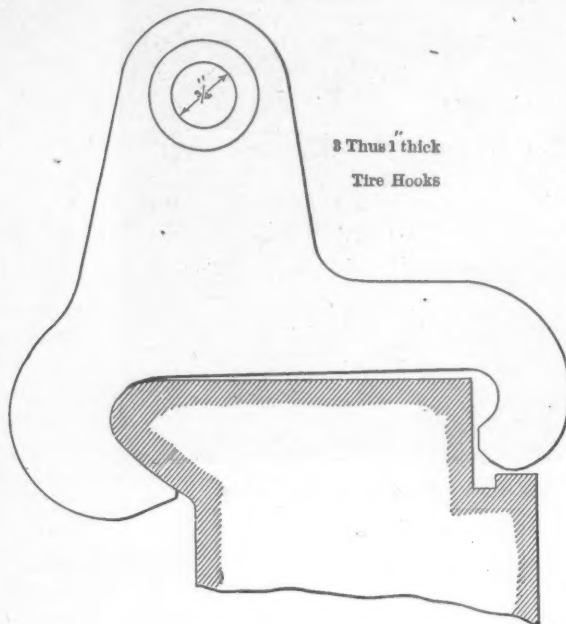
The expanding chuck for 40-in. tires, shown in Fig. 1, is in use at the Angus shops of the Canadian Pacific Railway. The tires which they use for their 40-in. wheels have retaining rings on both sides, and, it is, of course, necessary that the grooves for these rings be accurate in their relation to each other and to the outside of the wheel. The tires are first placed on the table of a 51-in. boring mill and are set to run true from the outside, and they are then bored and are grooved on the top side. They are then removed and are placed over the expanding chuck on another boring mill, are quickly chucked by tightening the nut on the $1\frac{1}{2}$ -in. bolt and are grooved on the other side. The expanding chuck has a lug on the bottom that fits in the table and is self-

centering, thus it takes but a very short time to place it on the machine. The tire hook, shown in Fig. 2, is used for putting the tires over this chuck, and for removing them.

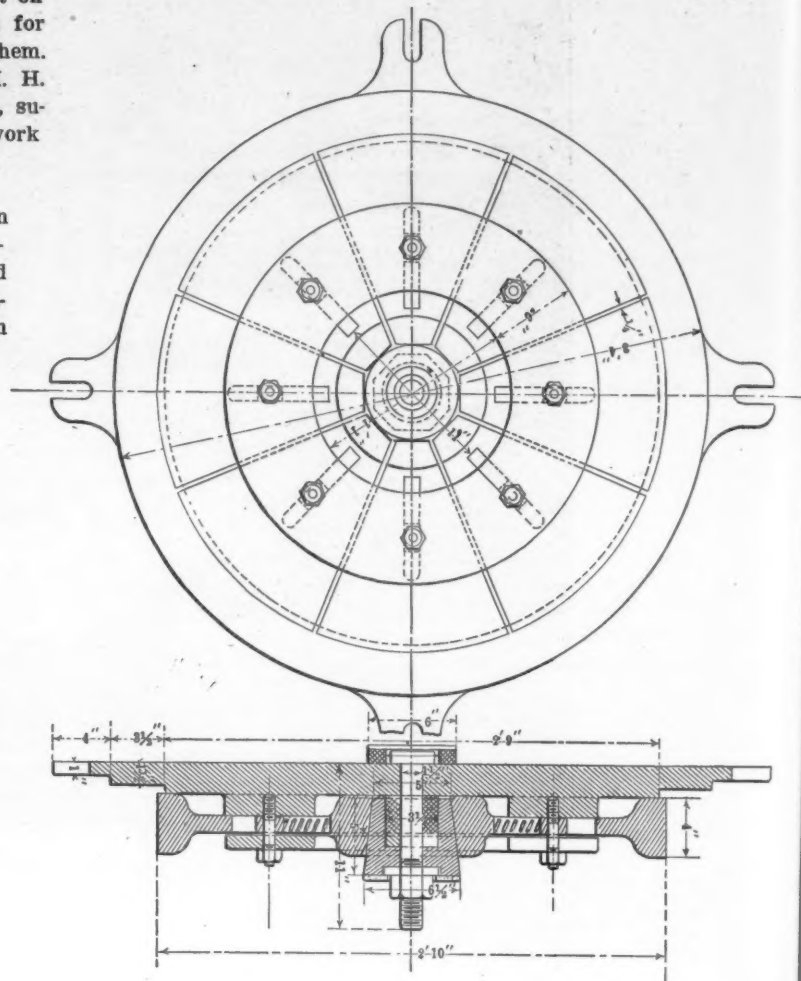
We are indebted for the above information to Mr. H. H. Vaughan, assistant to the vice-president, Mr. H. Osborne, superintendent of shops, and Mr. Gustave Giroux, piece work inspector.

MILLING TEETH IN REVERSE LEVER QUADRANTS.

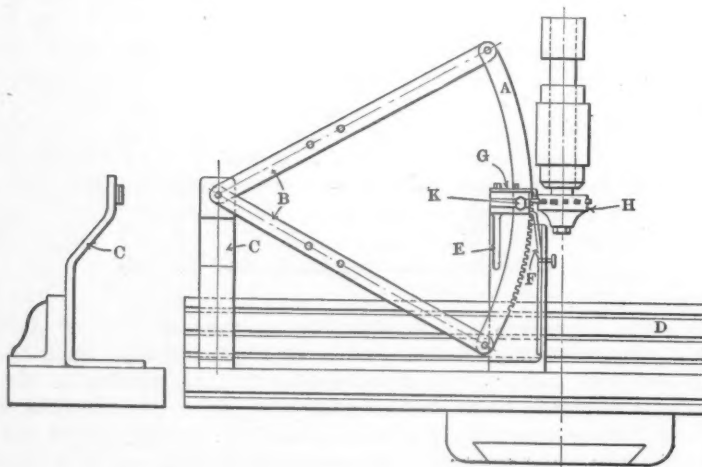
On page 228 of our June issue, in connection with an article on vertical milling machines in railroad shops, mention was made of a device used on the Becker-Brainard vertical milling machine at the Concord shops of the Boston & Maine Railroad for accurately milling the teeth in



HOOK FOR HANDLING TIRES ON AND OFF OF EXPANDING CHUCK.

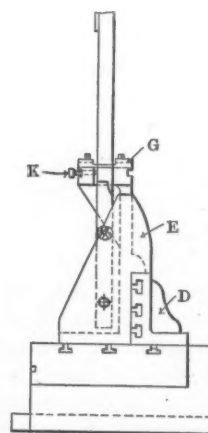


EXPANDING CHUCK FOR TRUCK WHEEL TIRES.



DEVICE FOR MILLING TEETH IN REVERSE LEVER QUADRANTS.

reverse lever and throttle lever quadrants. This device is shown in detail in the accompanying illustration. The arms B, which hold the quadrant A, may be adjusted to suit the length of the radius of the quadrant. The cutters in the tool holder H, are made to suit the shape of the teeth in the quadrant, and the tooth is cut as the table of the machine is fed forward. The quadrant is then dropped downward or moved upward a tooth and is held by the steel catches F or G, as the case may be, which regulate the space between the teeth. K is a set screw which securely holds the quadrant in place. C is a wrought iron support for the arms B; D is an angle iron which is fastened to the table and to which the support C and the



casting E are attached. The device is simple and is giving very satisfactory results. We are indebted for this information to Mr. Louis A. Abbott.

TRACTION EXPERIMENTS.—Traction experiments with ordinary farm wagons have been made for the past three years by the Civil Engineering Department of the Iowa State College, and very valuable data have been obtained. The average pull in pounds per ton on an old and very dirty gravel road in the worst spring condition is about 190 to 200 lbs., and on a better gravel road in the same condition about 135 to 150 lbs. The

traction on these roads in ordinary dry condition is between one-third and one-half the amounts mentioned. On earth roads in the worst spring condition the pull per ton ranges from 234 to 531 lbs., averaging about 330 lbs. In dry weather the pull on these roads is from 83 to 215 lbs., averaging about 125 lbs. These tests were made with farm wagons having 42 and 52-in. wheels and 1 3/4-in. tires, and show clearly the effect of bad roads on traction.

HEAVY RAILS.—The rails on the belt line railroad around Philadelphia are said to be the heaviest in the world, weighing 142 lbs. per yard, or 17 lbs. more than any previously used. They are ballasted in concrete, with 9-in. girders to bind them.



MIKADO TYPE FREIGHT LOCOMOTIVE—DEEPWATER RAILWAY COMPANY.

MIKADO TYPE FREIGHT LOCOMOTIVES.

DEEPWATER RAILWAY COMPANY.

The Deepwater Railway Company is receiving from the Baldwin Locomotive Works some Mikado type freight locomotives, which, considering their weight, are very powerful. These engines have a slightly greater tractive power than the tandem compound Mikado type locomotives for the Northern Pacific Railway, described on page 367 of our October issue. The Deepwater locomotives, with 22 by 28-in. cylinders, have driving wheels only 51 ins. in diameter, and are apparently intended for slow, heavy service, and will probably be used at Allegheny Summit and on some of the heavy mountain grades in West Virginia. The Rushton trailer truck is used. The leading dimensions of these engines are as follows.

MIKADO TYPE FREIGHT LOCOMOTIVE.

DEEPWATER RAILWAY COMPANY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	45,180 lbs.
Weight in working order, estimated	224,000 lbs.
Weight on drivers, estimated	180,000 lbs.
Weight of engine and tender in working order, estimated	340,000 lbs.

Wheel base, driving	14 ft.
Wheel base, total	31 ft. 1 in.
Wheel base, engine and tender	59 ft.

RATIOS.

Tractive weight ÷ tractive effort	3.98
Tractive effort x diam. drivers ÷ heating surface	.674
Heating surface ÷ grate area	.68.9
Total weight ÷ tractive effort	4.95

CYLINDERS.

Kind	Simple.
Diameter and stroke	22 by 28 in.

VALVES.

Kind	Balanced Slide.
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WHEELS.

Driving, diameter over tires	51 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	9¼ by 12 ins.
Driving journals, others, diameter and length	9 by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	5½ by 10 ins.
Trailing truck wheels, diameter	36 ins.
Trailing truck, journals	6 by 10 ins.

BOILER.

Style	Straight.
Working pressure	200 lbs.
Outside diameter of first ring	78 ins.
Firebox, length and width	102 by 72 ins.
Firebox depth	front 72 ins., back 62 ins.
Firebox plates, thickness	¾, 7/16 and ½ in.
Firebox, water space	5 in. front, and 4 in. sides and back.
Tubes, number and outside diameter	300-2¼ ins.
Tubes, gauge and length	11, 18 ft. 6 ins.
Heating surface, tubes	3,254 sq. ft.
Heating surface, firebox	160 sq. ft.
Heating surface, total	3,414 sq. ft.
Grate area	51 sq. ft.

TENDER.

Wheels, diameter	33 ins.
Journals, diameter and length	5 by 9 ins.
Water capacity	6,000 gals.
Coal capacity	10 tons.

HIGH SPEED STEEL MILLING CUTTERS.

The following extracts are taken from a very complete and valuable paper on "The Practical Use and Economy of High Speed Steel," presented by Mr. J. M. Gledhill of Armstrong, Whitworth & Co., Ltd., Manchester, England, before the Glasgow and West of Scotland Foreman Engineers and Ironworkers' Association.

ANNEALING.

When making tools that require to be machined or cut to form, it is of course necessary to have the steel carefully and uniformly annealed, or softened, to facilitate machining operations. The process of annealing is one of much importance, and is best performed in specially designed sealed furnaces, constructed as "Muffles," so that the required heat is obtained uniformly by radiation, and the flame does not impinge on the steel. In addition to softening the steel and rendering it easy to machine, annealing has the effect of bringing the steel into a more uniform and homogeneous condition by eliminating the molecular strains which are set up in hammering and rolling, so that when the finished steel is heated preparatory to hardening, equal expansion follows, and also equal contraction when cooled. It will thus be seen that should the steel be not annealed uniformly throughout, risks of tools cracking or warping in hardening are very considerably increased.

For finished and expensive tools of intricate or irregular shape in which unequal expansion and contraction are likely to operate suddenly, it is advisable to re-anneal such tools before hardening so as to release any strains that may have been

set up by machining, and thus leave the metal in as normal a condition as possible, so minimizing any tendencies towards cracking or warping, especially the latter, after hardening.

HARDENING AND TEMPERING.

With regard to the hardening and tempering of specially formed tools of high-speed steel, such as milling and gear cutters, taps, screwing dies, reamers, and other tools that do not permit of being ground to shape after hardening and where any melting or fusing of the cutting edges would be fatal, and must be prevented, the method of hardening is as follows: A specially arranged muffle furnace (illustrated in Fig. 1) heated either by gas or oil and consisting of two chambers lined with fireclay is employed, the gas and air entering through a series of burners at the back of the furnace, and so under control that a temperature up to 2,200 deg. F. may be steadily maintained in the lower chamber, whilst the upper chamber is kept at a much lower temperature.

The mode of procedure is now as follows: The cutters are first placed upon the top of the furnace until they are warmed through, after which they are placed in the upper chamber and thoroughly and uniformly heated to a temperature of about 1,500 deg. F., or say, a medium red-heat, when they are transferred into the lower chamber and allowed to remain therein until the cutter attains the same heat as the furnace itself, viz., about 2,200 deg. F., and the cutting edges show a bright yellow heat, having an appearance of a glazed or greasy surface. The cutter should then be withdrawn whilst the edges are sharp and uninjured, and revolved before an air blast until the red has passed away, and then whilst the cutter is still warm—that is, just permitting of its being

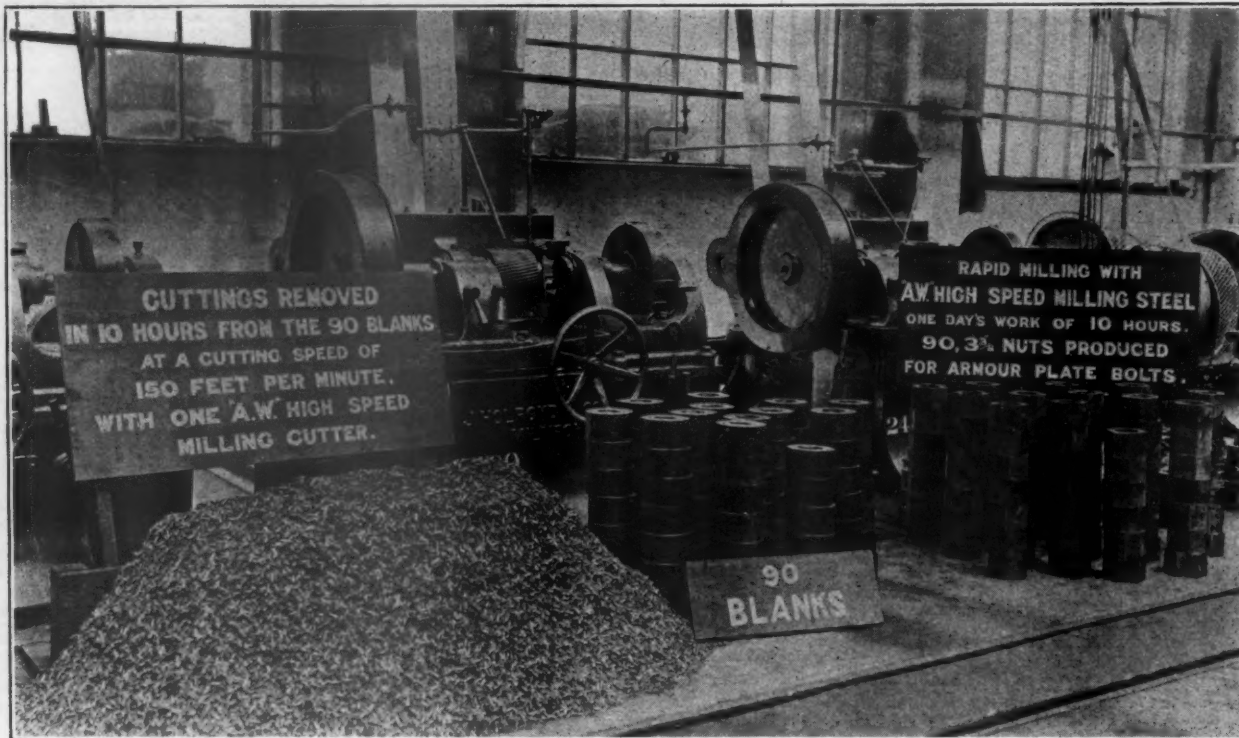
handled—it should be plunged into a bath of tallow at about 200 deg. F. and the temperature of the tallow bath then raised to about 520 deg. F., on the attainment of which the cutter should be immediately withdrawn and plunged in cold oil, or preferably if the cutter is a large one, allow it to cool with the tallow to normal temperature. When blast is not available small cutters may be hardened by quenching in oil from yellow heat.

There are, of course, various other ways of tempering, a good method being by means of a specially arranged gas-and-air stove into which the articles to be tempered are placed, and the stove then heated up to a temperature of from 500 deg. F. to 600 deg. F., when the gas is shut off and the fur-

nace with its contents allowed to slowly cool down. It is most important that the initial heating of the article to be hardened should be slowly and thoroughly effected, for unless the heating be uniform the expansion will be unequal and the risks of cracking and warping greatly increased.

SELECTION OF STEEL FOR CUTTERS.

Few shop tools are more expensive to make and maintain than milling cutters, and it is therefore of the utmost importance that the steel from which they are to be made shall be of the highest possible quality, for the cost of the steel is frequently but a small fractional part of the cost of the finished cutter, making it decidedly risky—and of more than doubtful economy—to use steel other than the best obtainable,



MAKING HEXAGON NUTS FROM ROLLED BARS.

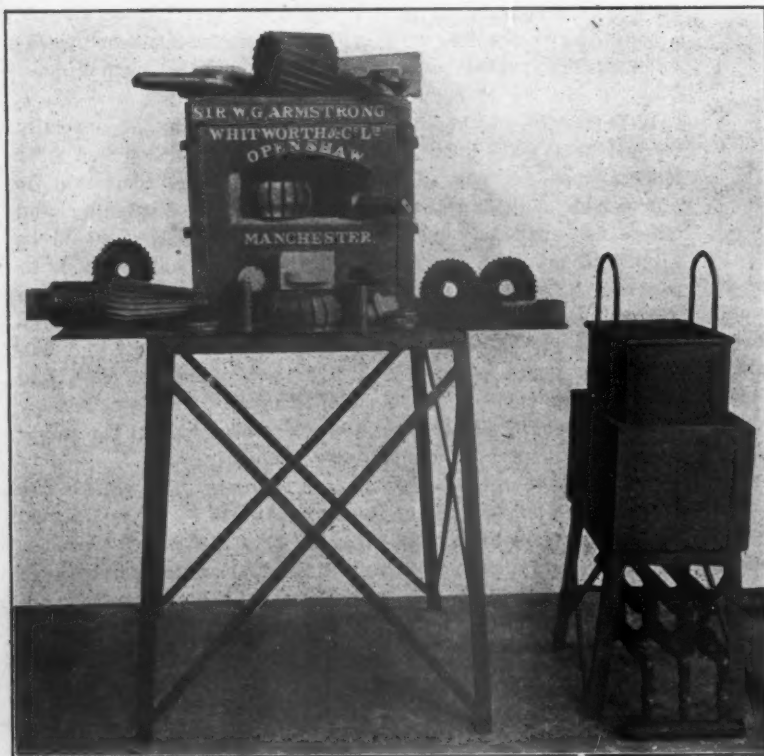
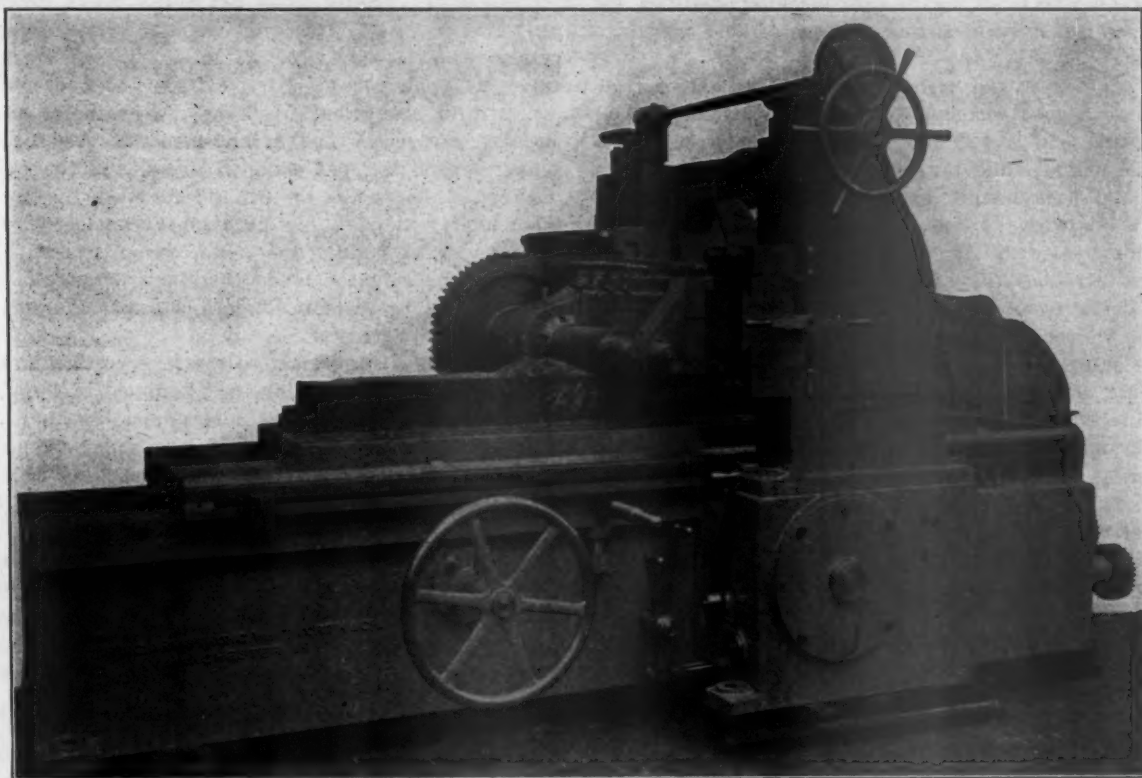


FIG. 1—MUFFLE FURNACE FOR HARDENING MILLING CUTTERS, ETC., OF "A.W." HIGH SPEED STEEL.



CIRCULAR FURNACE FOR HARDENING LARGE CUTTERS.

when the labor that has been put upon it, added to the cost of the steel, is rendered useless by the cutter cracking during hardening. It is usually necessary after a milling cutter



HIGH SPEED SLAB MILLING MACHINE WITH 40 H.P. MOTOR; "A W." CUTTERS CUTTING STEEL AT 180 FT. PER MINUTE; $\frac{1}{2}$ IN. DEPTH OF CUT, $7\frac{1}{2}$ IN. WIDTH; FEED, 6 IN. PER MIN.

completely worn down, for it to be annealed, so that it may be re-cut. It is very largely because of this that steel of the greatest purity should be used, otherwise marked deterioration will be observed each time the cutter is re-hardened—even should cracking be avoided. Some recent tests of this character showed less than 5 per cent. loss of efficiency in the "A W." steel after seven times annealing and hardening of the same piece of metal.

Steel for use in milling and gear cutters should be reasonably tough, with a capacity for retaining a sharp cutting edge, and combined with great powers of endurance, for if the edges become quickly dulled greater power will be required, while the resulting finish of the work will not be of a satisfactory character, and since the grinding and setting up of a milling cutter is comparatively a more or less costly operation, only steel possessing qualities as enumerated above should be used if good results and economies are to be effected. The following will clearly show the very great advantages to be derived from the use of cutters made from high-speed steel.

PRACTICAL RESULTS.

Operating on rolled steel bars with cutters of "A W." steel a total of 90 hexagon nuts for $3\frac{3}{8}$ -in. diameter bolts are produced each day (Fig. 2.). The cutting speed is 150 ft. per minute; maximum depth of cut, $\frac{5}{8}$ in.; width, 7 ins.; 675 lbs. of metal being removed per day. The cutters are 8 ins. diameter, and usually mill 300 nuts without grinding. Owing to the intermittent character of the cut, these cutters are very severely tried indeed, but so far have answered admirably. It may be here noted that these cutters effected such a great saving in costs and machines as to repay the cost of making same after less than two days' work.

Another really remarkable piece of milling work is evidenced by the following extract from a letter received from Cleveland, Ohio: "We have made a $2\frac{1}{2}$ -in. diameter, $\frac{3}{4}$ -in. face, 12 x 53 deg. cutter from the 'A W.' steel blank, and used it on milling spiral mills made from annealed tool steel; depth of cut was 5-16 in.; cutting speed, 62 feet per minute. .024-in. feed per revolution = 2.28-in. per minute; 924 ins. were cut, the cutter showing no signs of wear. Speed was then increased to 113.2 ft. per minute with a feed of .024 in. per revolution = 4.15 ins. per minute, and after cutting an-

other 924 ins. the cutter was still in fairly good condition and would have milled many more if the class of work had not required a clean and smooth cut. The cutter was then reground, only requiring .003 in. grinding to sharpen. I consider this test and the result thereof the very best in my experience."

Length of time for first operation.....	6 $\frac{1}{4}$ hours.
Length of time for second operation.....	3 $\frac{1}{4}$ hours.
Total length of time for both operations.....	10 $\frac{1}{2}$ hours.

NEW BALTIMORE AND OHIO CONSOLIDATION LOCOMOTIVES.

BY J. E. MUHLFELD.

The following features were considered in the design, construction, maintenance and operation of the E-27 class, consolidation type locomotives for the Baltimore & Ohio Railroad.

A reasonable first cost, maximum efficiency for the service; within the track, weight and clearance requirements; the greatest proportion of adhesive to total weight; a capacity to handle the heaviest gross tonnage practicable at the highest desired speed; economy as regards maintenance and fuel and water consumption; a substantial construction and of the least number of parts and a capacity to perform continuous service without liability of failure. A general design of freight locomotive, suitable for handling heavy tonnage at fast or slow speeds, over level and mountainous, open and tunnelled railroad of varying curvature and gradient. A boiler of simple design and substantial construction, with ample grate area (in one plane) and firebox heating surface, together with provision for the free circulation of the water and the unrestricted passage of the gases, and suitable for the consumption of a cheap grade of run of mine, bituminous coal. A maximum tractive effort for starting trains with the least number of revolutions of driving wheels per mile run. The shortest rigid wheel base consistent with driving wheels of 62 ins. maximum diameter, together with a maximum weight on drivers permissible with clearance and weight, and in view of maintaining sufficient weight on

the pony truck wheels to secure safe tracking qualities for high speed down mountainous lines of considerable curvature and gradient.

Bushings applied to the cylinders in the initial construction, to secure a good wearing metal for the piston, as well as strong walls and a suitable metal for the strength required in the cylinder and the saddle casting. A half saddle with front and back flanges extending down to the lowest position in a line with the center of the cylinder, and the half saddles well-bolted with staggered bolts in deep front and back flanges to reduce the liability of one half the cylinder casting loosening from the other half.

Frames of a strong section in width and depth, with large radii at the junction of the main rails and the pedestals to insure against concentration of stresses and breakage; substantial connections and keying lugs between the main and front frames and the cylinders; a good fastening of the boiler to the frames and cylinders; a substantial cross bracing between the frames and to secure the frames to the boiler; a substantial deck casting to cross brace the frames at the rear of the boiler.

An arrangement of equalized pressure driver brake that will admit of the brake shoes being applied to the front of the wheels to relieve reverse stresses to the spring and equalizing gear, and at the frames where the brakes are applied;

reverse lever, throttle lever, engineer's brake valve, straight air brake valve, injectors, sand lever, whistle lever valve, water gauge cocks, water glass, steam blower valve, ash pan blower valve, cylinder cock operating lever, etc., within convenient reach of the engineer when sitting on the cab seat. The arrangement of the rocking grate shaker levers, ash pan damper levers, and the operation of the furnace doors and the distance between the fire hole and the tender coal gates has been given considerable attention, with a view of making the same convenient for the firemen. The coal space in the tender has been arranged, so that all the coal will be brought forward, as near the coal gates as practicable, by gravity.

A crosshead arrangement so that the vertical wear may be taken up without disturbing the alignment of the guides. An arrangement of piston rods and guides, so that the metal packing may be applied when the crank pins are on the front dead center, and so that the piston packing rings can be applied without disconnecting the piston rod from the crosshead; slide valves having $1\frac{1}{4}$ ins. outside and $\frac{1}{8}$ in. inside lap, with $\frac{1}{16}$ in. lead in full go ahead and back-up gear with $2\frac{3}{4}$ in. throw of the eccentric, in connection with a motion gear of the most simple design and construction, and the fewest number of bearing parts consistent. Five of these locomotives will be equipped with the Walschaert motion



CONSOLIDATION LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.

also to permit of the application of a push-down type of driver brake cylinders and cranks to the frame at the rear of the driving wheel, where they will be accessible for repairing, cleaning and adjustment. We consider that the application of driver brake cylinders between the frames and at the rear of the cylinders, interferes with the substantial bolting and accessibility to the frame splices and takes up space that is desirable for inspection, and causes stresses at that point which are undesirable. An ample storage of compressed air in two reservoirs of combined 60,000 cu. ins. capacity, embodying good radiating and condensing surfaces, which in connection with an 11-in. air pump, should fully meet the requirements for the proper handling of the longest trains on a level track and on down mountainous grades.

A heavy section of main and side rods around the brasses, knuckle joint pin and other openings. The elimination of unnecessary piping from the outside of the boiler, which is liable to leakage and to obscure the vision of the engineer. Substantial and positive grate shaking gear, ash pan dampers, furnace doors, self-cleaning ash pans, etc. Steam balanced piston packing rings to the pistons, to reduce the wear of the cylinders and the packing rings and to maintain the piston in a tight condition; steam balanced slide valve balance strips, to insure the least wearing of the strips and the grooves in which they are contained.

A convenient and roomy cab, well-ventilated for tunnel service, and having the lubricator, steam and air gauges,

gear, similar to that applied to the Mallet articulated locomotive No. 2400, for the purpose of making comparison and determining as to the advisability of future applications of the Walschaert gear, instead of the Stephenson. Brass eccentric straps and brass shoes and wedges in connection with cast steel driving boxes. A substantial design of driving wheel centers with the maximum bearing face between the tire and the wheel center. All bearing surfaces of the boiler expansion braces, running and equalizing gear, brake gear, motion gear, etc., are case-hardened and of wrought iron, or open-hearth steel.

A tender underframe of deep section channel, with the cistern equipped with collision angle and iron coal gates, to reduce the liability of the tank or coal being forced ahead over the tender frame in event of accident. The cistern designed with a deep water bottom extending to the extreme front of the tender frame, in order to maintain an ample proportion of weight over the front tender trucks at all times.

The construction of the first or sample locomotive No. 2500, which was put into service during the month of August, was carried on in advance of the regular order, to give an opportunity for discussion and a practical demonstration of the design, construction and operation, the result of which might lead to discussion that would affect the balance of the locomotives. The motive power department appointed three committees, one consisting of the superintendents of motive power, mechanical engineer and engineer of tests and shop

master mechanics; another of the division master mechanics, and the third of the road foreman, each bringing with them one locomotive engineer and fireman of each division. After the arrival of the sample locomotive at Baltimore, certain parts were removed, and the members of these committees were given every opportunity to make an examination of the details in the general design and construction. The locomotive was then connected and put under steam, so that the members of the committees could have an opportunity to observe as to the operation, hauling capacity and steaming and riding qualities. The committees were instructed to submit reports after their investigation, giving their criticisms and recommendations and reasons for any changes that they would suggest making.

These reports contained many valuable suggestions, which, coming from the people who will be in direct charge of the maintenance and operation of the locomotives over level and mountainous divisions, have been of considerable benefit in producing a design that the motive power people feel will give the most satisfactory general results. It is felt that this method of producing motive power equipment by a combination of drawing office and practical shop and operating knowledge of locomotive design and construction, will result to the best advantage.

In deciding upon the types of new locomotives to be built and in designing, we have thought that only those of maximum power should be considered, and that the fewest number of standard types adapted to the present and future needs of the different service and to meet the contemplated physical improvements of the property should be decided upon. With the above in mind, it was decided to classify the 250 locomotives into three groups, five being a switching type for special service, thirty-five, a Pacific type for passenger and fast freight service, and 210 of the consolidation type for slow and fast freight service.

As the principal work to be accomplished by a railroad is the movement of its trains from one terminal to another on time, we have thought that the monthly mileage that can be derived from any class of properly designed, constructed and maintained motive power, is limited only by the terminal delay and the despatch with which it can be handled over a division, even though the speed, grade and curvature are factors that may largely control the loading of the locomotives, as well as the cost of their operation. With the demand for faster schedules, we have followed out the general tendency and more desirable practice of increasing the diameter of the driver wheels and the length of the stroke, which, combined with a proportionately reduced diameter of cylinder, results in less liability for wear and tear on the track and locomotives, and decreased operating expense due to less revolutions per coupled wheel per mile, and a material gain in reduced boiler and machinery stresses.

The demand for great locomotive tractive power in one unit, has frequently resulted in the use of extreme diameters of cylinders, reduced spread of frames, increased distance between centers of cylinders and greater length of rigid wheel base, which proportions have transmitted stresses to the cylinders and connecting frames, that have resulted in a large number of breakages of these parts. Furthermore, the failure of the higher steam pressure to produce efficient and economical results, in many modern locomotives, has frequently been due to defective boiler, cylinder, frame and motion gear design and construction; excess weight and inferior quality of material applied to frictional parts; neglect in the details of design; inadequate provision for drifting and condensation, priming, method for lubrication, etc. We have kept in mind, that when the steam pressure is not maintained, a locomotive cannot develop its working power, and that the modern type is under the further disadvantage of having to haul an increased dead weight, especially on mountainous grades. Therefore, by combining in the new construction, features that we have found from practical experience have met the local conditions, and through the elimination

of individual preferences and frills, we believe that a plain, simple, practical design and construction has been produced that will give generally satisfactory results.

The general dimensions of the consolidation locomotives, which are being built by the American Locomotive Company, are as follows:

GENERAL DATA.	
Gauge.....	4 ft. 8½ ins.
Service	Freight.
Fuel	Bituminous coal.
Tractive power	41,100 lbs.
Weight in working order	208,500 lbs.
Weight on drivers	185,900 lbs.
Weight on leading truck	22,600 lbs.
Weight of engine and tender in working order.....	345,900 lbs.
Wheel base, driving	16 ft. 8 in.
Wheel base, total.....	25 ft. 7 ins.
Wheel base, engine and tender	59 ft. 8½ ins.
RATIOS.	
Tractive weight ÷ tractive effort.....	4.52
Tractive effort x diam. drivers ÷ heating surface.....	888.
Heating surface ÷ grate area.....	49.1
Total weight ÷ tractive effort.....	5.07
CYLINDERS.	
Kind	Simple slide valve.
Diameter and stroke.....	22x30 ins.
Piston rod, diameter	4 ins.
VALVES.	
Kind	Richardson Balance.
Greatest travel	6 ins.
Steam lap.....	1¼ in.
Exhaust lap	¼ in.
Setting	1/16 in. lead in full gear front and back.
WHEELS.	
Driving, diameter over tires.....	60 ins.
Driving, thickness of tires.....	3 ins.
Driving journals, main, diameter and length.....	10x13 ins.
Driving journals, others, diameter and length.....	9½x13 ins.
Engine truck wheels, diameter.....	33 ins.
Engine truck, journals	6 by 10 ins.
BOILER.	
Style	Straight top.
Working pressure.....	200 lbs.
Outside diameter of first ring.....	74 7/16 ins.
Firebox, length and width.....	108½x75¼ ins.
Firebox plates, thickness	¾ and ½ in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter.....	282, 2½ ins.
Tubes, gauge and length.....	11, 15 ft. 10 ins.
Heating surface, tubes.....	2,612.80 sq. ft.
Heating surface, firebox	162.26 sq. ft.
Heating surface, total.....	2,775.06 sq. ft.
Grate area	56.5 sq. ft.
Exhaust pipe	Single, 5¼ and 5½ in. nozzle.
Smokestack, diameter	18 ins.
Smokestack, height above rail.....	14 ft. 7¼ ins.
Centre of boiler above rail.....	118 ins.
TENDER.	
Tank	Water Bottom.
Frame	13-in. channels and plates.
Wheels, diameter.....	33 ins.
Journals, diameter and length.....	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.

RESULTS OF MOTOR DRIVEN TOOLS AT THE McKEES ROCKS SHOPS.

During 1903 and 1904 we devoted considerable space to a description of the McKees Rocks Shops of the Pittsburg & Lake Erie Railroad, and to their equipment, and especially to the application of individual motors to both the old and new machine tools. This was one of the first railroad shops where machine tools were extensively equipped with individual motors, and as they have now been in operation for about two years, the following results, which are taken from a paper on "Machine Tool Practice," read by Mr. G. M. Campbell, electrical engineer of the railroad, before the Engineers' Society of Western Pennsylvania, are of interest:

One argument often brought up against the old belt-driven shop was the great waste of power, and the same is brought up against the use of individual motors as against group driving on account of the lower efficiency of small motors, but the argument is not worth considering when the total amount of the power consumed is taken account of. The cost of power is very rarely 2 per cent. of the cost of the output in shops of any size. Suppose by the strictest economy 50 per cent. of the cost of power could be saved, yet the net saving would be only 1 per cent. During the year 1904 the total cost for power at the Pittsburg & Lake Erie shops was slightly over one-half of 1 per cent. of the cost of the labor and material.

Some information concerning the motor equipped shop of the P. & L. E. R. R. at McKees Rocks may be of interest. The shops are compactly situated and consequently direct current

could be used to advantage; the voltage in use is 250. For machine work, the multi-voltage system of drive is used and with excellent results. The voltages vary by steps of 40 from 40 to 240, with intermediate and additional steps obtained by means of field resistance. The controllers in use have 21 steps in forward motion, giving approximately 10 per cent. increments. Individual motor drive was carried to a much greater extent than in any shop previously put up, but experience has not shown that any mistake was made in so doing. In the machine shop only one small group of tools is driven from shafting. All the others have individual motors. The tools in the group above referred to are such tools as drill grinders, polishers, bolt threading machines, etc. In the wood working shops, however, group driving is the rule; individual motors are used only on the larger machines; in general in machines of this class no change in speed is required and therefore group driving is entirely satisfactory.

The complete list of all motors installed numbers 83. This list of motors shows sizes as follows:

Number.	Rating.	Total H. P.
1	2	2
6	3	18
6	4	24
11	5	55
3	6	18
16	7½	120
1	9	9
10	10	100
1	13	13
13	15	195
3	20	60
7	25	175
3	35	105
1	45	45
1	60	60
83		1000

It should be noted that the rating is for full speed and voltage, not the actual horsepower obtainable at all times and not the horsepower required by the machines. The horsepower rating for the variable speed machines would be only 40 to 50 per cent. of the motor rating. The other motors around the plant would add about 450 h.p. and the cranes about 250 h.p., bringing the total motor rating up to about 1,700 h.p. Of the 83 motors, 75 are used for individual drive and 8 for group driving, 5 of these 8 being in wood-working shops; 27 are constant speed and 56 variable speed motors. The total cost of these 83 motors was \$20,275, or an average cost of \$244.50, exclusive of mounting. The same motors could now probably be bought from 15 to 25 per cent. less. The average horsepower of these 83 motors is 12.05.

During the year 1904, the average horsepower taken by all machine tool motors was about 200 during working hours, but all the tools listed above were not in operation. The average power consumption at present is about 300 h.p., or about 30 per cent. of the horsepower rating of the motors. During the year 1904, the average power consumption of the machine tools was 17.3 per cent. of the output of power house; it was 38.71 per cent. of the total electric power; lighting was 24.9, heating motors 23.78 per cent. The electric power consumption of the machine tools including cranes and blast fan was subdivided as follows:

Variable speed tools.....	39.71%
Constant speed tools.....	26.80%
Blast fans	28.44%
Cranes	5.05%
1	100.00%

The total cost of power for the machine tools, including the cranes, was \$2,662.66, this does not include the maintenance of motors.

In addition to the shops being well equipped with motor-driven tools, there are at present in service seven cranes from 120 ton to 7½ ton capacity. Three more will be added shortly. The capacity of the power house for electric work is 600 k.w. full load rating, or 750 k.w. with 25 per cent. overload. There is space for one additional generator of 150 k.w. capacity.

The following few items are given concerning speeds of cutting. These are not given as maximum and are not special tests, but are every day practice, as previously stated.

P. & L. E. R. R. CO.—MCKEES ROCKS SHOPS.

SAMPLE CUTTING SPEEDS.						
No.	Machine Description.	Wt. Lbs.	Removed per Min.	Speed Ft. per Min.	Material.	Remarks.
10	Lathe	2.63	106		Cast iron	
10	"	2.33	44		Steel	
16½	"	1.69	170		"	
13	"	3.43	43		"	
20	"	4.2	54		Wrought iron	
14	Wheel Lathe	6.3	13.2		Steel	
23	"	5.3	15.5		"	
51	Planer	3.2	30		Cast steel	
52	"	18.3	29		Cast iron	
92	Shaper	2.03	120		Brass	60 strokes, min.
39	Drill	0.52	74.5		Wrought iron	1¼-in. drill
147	"	0.88	53.9		"	1¼-in. drill
33	Boring Mill	1.1	59.5		Steel	

Railroad shops are in general repair shops, so the weight of metal removed is not at all remarkable, compared to many tests which have been reported. To show the excellent results obtained in the new shops the following figures may be noted. The shops were opened in February, 1904, but were not in full operation until some months later. It, of course, took some time to become used to new conditions, so that results for year 1905 would probably show a higher increase over year 1903.

Locomotives repaired	1903	64
"	1904	145
Locomotives built	1903	None
"	1904	10
New fireboxes	1903	5
"	1904	21
Cost of labor	1903	\$216,472
"	1904	\$236,871
An increase of only 9.5%		
Credit for outside work	1903	\$4,800
"	1904	\$61,516

The force of men is now 25 per cent. more than during 1903, but the output is very considerably greater. Formerly five to seven locomotives were overhauled per month, now from fourteen to twenty. Very much of the increase in number is due to the repairing of locomotives for other roads.—Erie, Lake Shore, Pennsylvania and Union R. R. The new shops are considered an excellent investment despite the heavy first cost, and it is estimated that they will have paid for themselves, including first cost and interest, in ten years or less.

DIES FOR FORGING MACHINES.

BY S. J. UREN.*

In a shop where orders for a large quantity of car and locomotive forgings come in daily, the first thing that enters the foreman's mind is how to get it done quickly, and I find by experience the best way is by the forging machine and bulldozer. It is surprising the large amount of forgings that can be turned out by one of these machines daily, and no well-equipped shop should be without them.

With our 4-in. Ajax forging machine we are turning out the following: Swing hangers for passenger car trucks, bolsters for all baggage and postal cars, crown bars for locomotive boilers, crow-feet for locomotive boilers, drawbar straps for baggage and freight cars, connecting rods for S. P. switch stands, slide plates for switches, and other forgings too numerous to mention.

In designing the dies for the different work that can be done on these machines the first thing to do is to figure out the amount of stock it takes to make the piece required, which will give you the length of die to use. In making swing hangers for passenger car trucks (Fig. 1) we use two pieces of iron ⅞ in. x 3 in. x 19 in. long. We lay them together, put them in a small oil furnace and in a very short time we have a welding heat about 10 ins. long on them. We take them to the machine, place them in the dies and press the lever down. The header enters the dies, the back-stop on the machine holds the iron from slipping back, and the head on the hanger is made. We then turn it around, put it in the same die a little higher up and press the lever down. The mandrel in the header-block enters the die, pushes the wings of the hanger apart, and the hanger is completed. We make from fifty to sixty of these hangers per day, so it does not take long for a machine of this kind to pay for itself.

*From a paper read before the Pacific Coast Railway Club.

Care must be taken in setting dies in the machine and all bolts must be tightened before starting. Fig. 1 shows the dies used for making these hangers, the length of headers and size of dies required. The die seat is 21 ins. long when the dies are closed and the header-block is up to the end of the stroke. The space between the header-block and the dies is $4\frac{1}{4}$ ins. When shorter dies are used the punch or header

heat on the end of the bar, place it in the machine and press the lever down. The dies close, the header comes up, hits the end of the bar, welds and presses it into shape, and we have one end of the bolster completed. Reverse the end, go through the same operation, and we have a bolster completed in quicker time than it takes to explain it. I find by testing this class of work by the steam hammer process

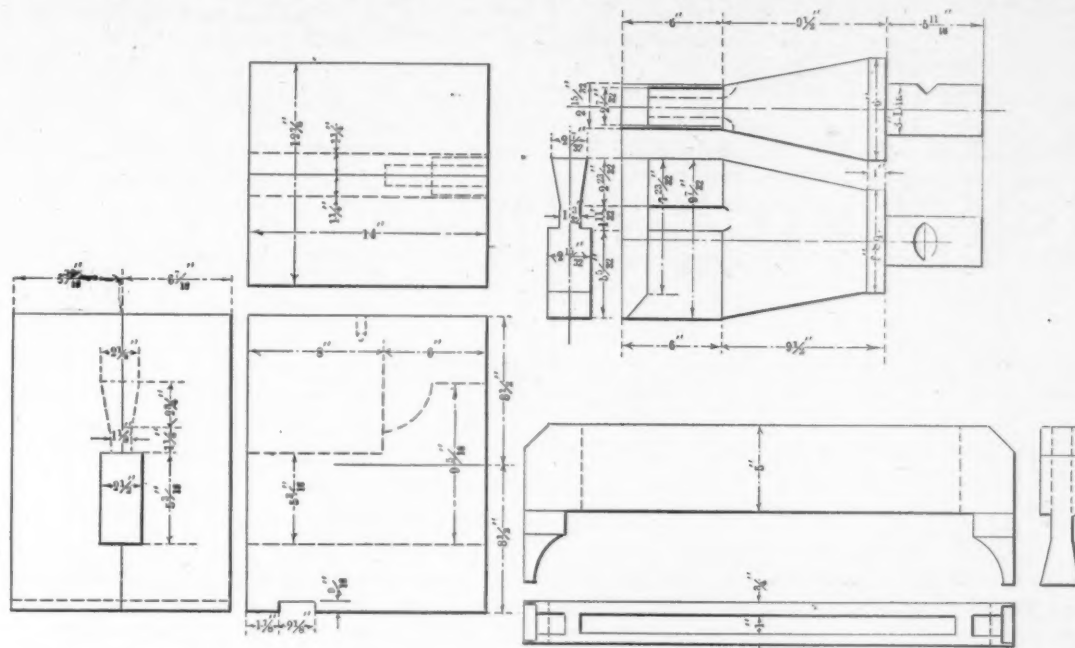


FIG. 2—DIES AND HEADERS FOR CROWN BARS.

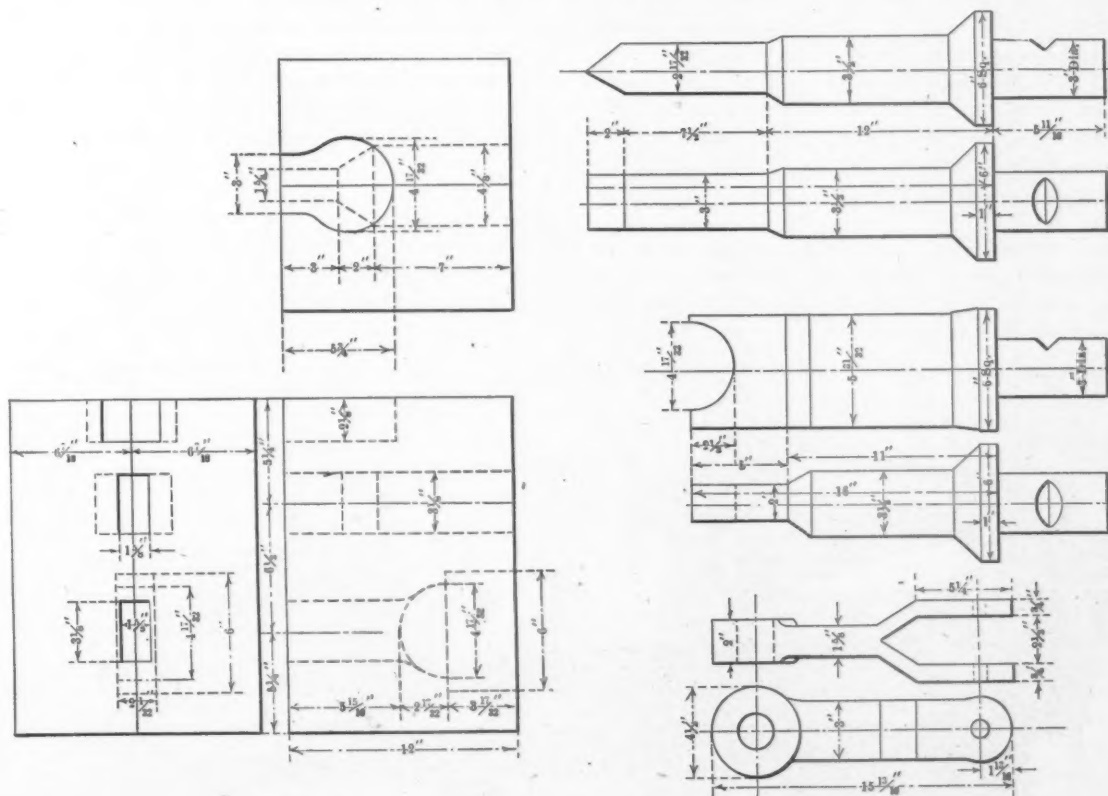


FIG. 1—DIES AND HEADERS FOR MAKING SWING HANGERS.

must be increased in length in the same proportion. As the length of the dies is decreased when headers, punches or mandrels enter the dies the distance they go into the dies must also be increased.

In making the bolsters for the tea and silk cars recently built in the Sacramento shops we take our 1 x 12 in. bars, cut them off 2 ins. longer than the length required, lay a piece of 1 x 5 x 12 in. on the end (this allows 1 in. on each end of the bar for upsetting and welding), get a nice white

that it will stand a better test than similar work done by hand. These ends are put on at the rate of twenty to twenty-five per day.

Crown bars (Fig. 2) for locomotive boilers are made in a similar manner—by laying a piece of $1\frac{1}{2} \times 3 \times 9$ in. between two pieces of $\frac{3}{4} \times 5$ in. by any length required, welding and pressing into shape by one operation.

We have a great many target connecting rods (Fig. 3) for S. P. switch stands to make in the Sacramento shops, and

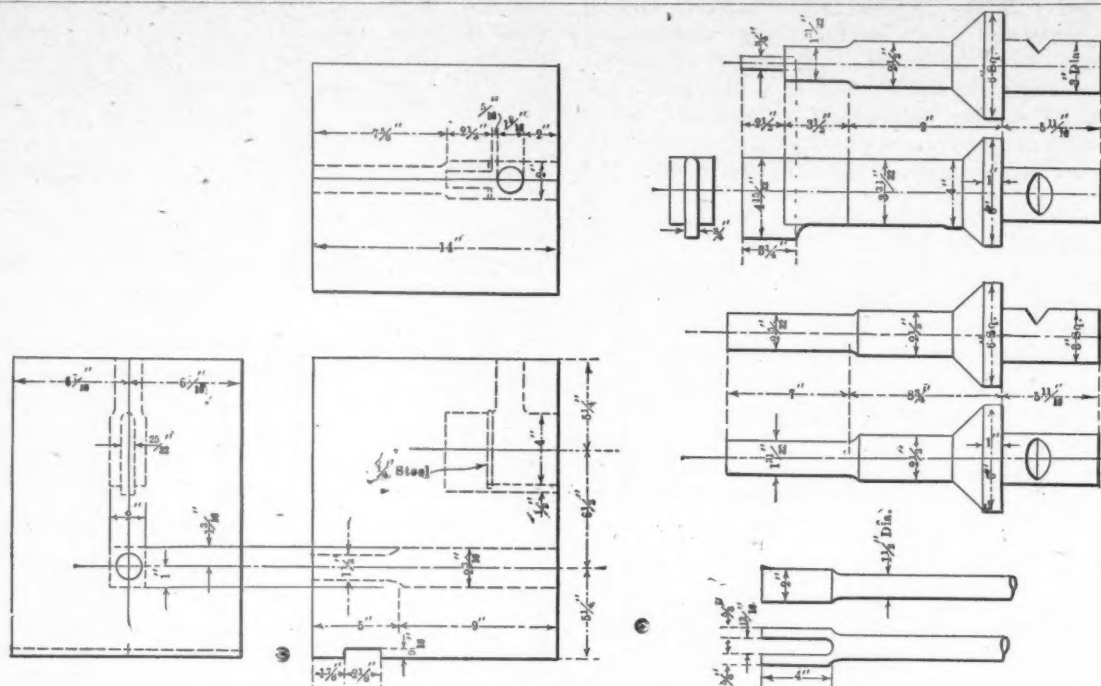


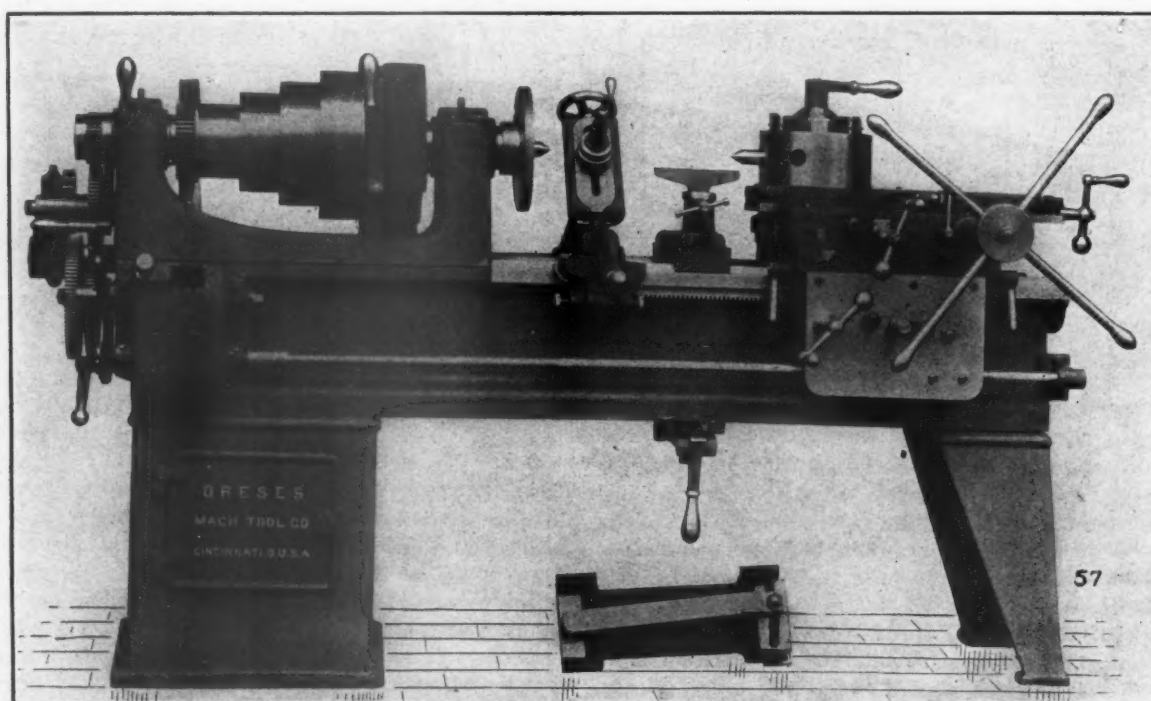
FIG. 3—DIES AND HEADERS FOR TARGET CONNECTING RODS.

this is a simple job made on the machine. we take our bar of 1½ in. round iron the required length, get a white heat on end of it about 11 or 12 ins. long, place it in the lower portion of the die and press the lever. The plunger comes up and makes an end on the bar 2½ x 2 x 4½ ins. long. We then take it out of the lower portion of the die, place it in the upper portion in a vertical position, and the punch comes up and punches the jaw. Now, we have the jaw on the rod completed. We then take the rod to a 3-in. Ajax forging machine that we have close by for the upsetting of the other end. This takes but a very short time, and we have a target connecting rod completed without a weld. The idea in taking these rods from one machine to the other is to save time of changing and setting dies.

The bulldozer, as well as the forging machine, is a machine that should be in every blacksmith shop where there is much bending and forming to be done, such as drawbar straps for passenger or freight cars, arch-bars for freight or

tender trucks, side-sill steps, uncoupling levers, carry irons, corner irons, links and a large amount of other wrought-iron work that is used on cars and locomotives.

The face of the machine which is constantly in use in the Sacramento blacksmith shop is fourteen inches high, 5 ft. 4 ins. wide, and has two grooves running the width of the face cut out the same as the grooves in the bed of a planer. We have two rollers, simply constructed, that we fasten to the face of the machine with the bolts slipped in the grooves. Consequently we can shift these rollers, to bend straps, from $\frac{1}{2}$ in. width of opening up to 5 ft. When any material has to be bent at right angles we slip one of the rollers out. The plate on the back-stop of the machine is constructed similarly to the face-plate, and we fasten all dies, formers and mandrels to this. The material is held in the formers or mandrels, before bending, by a hinged clamp made for the purpose. The bulldozer we use is a No. 7, and I think, is large enough for all railroad purposes.



DRESES 20-INCH UNIVERSAL MONITOR LATHE.

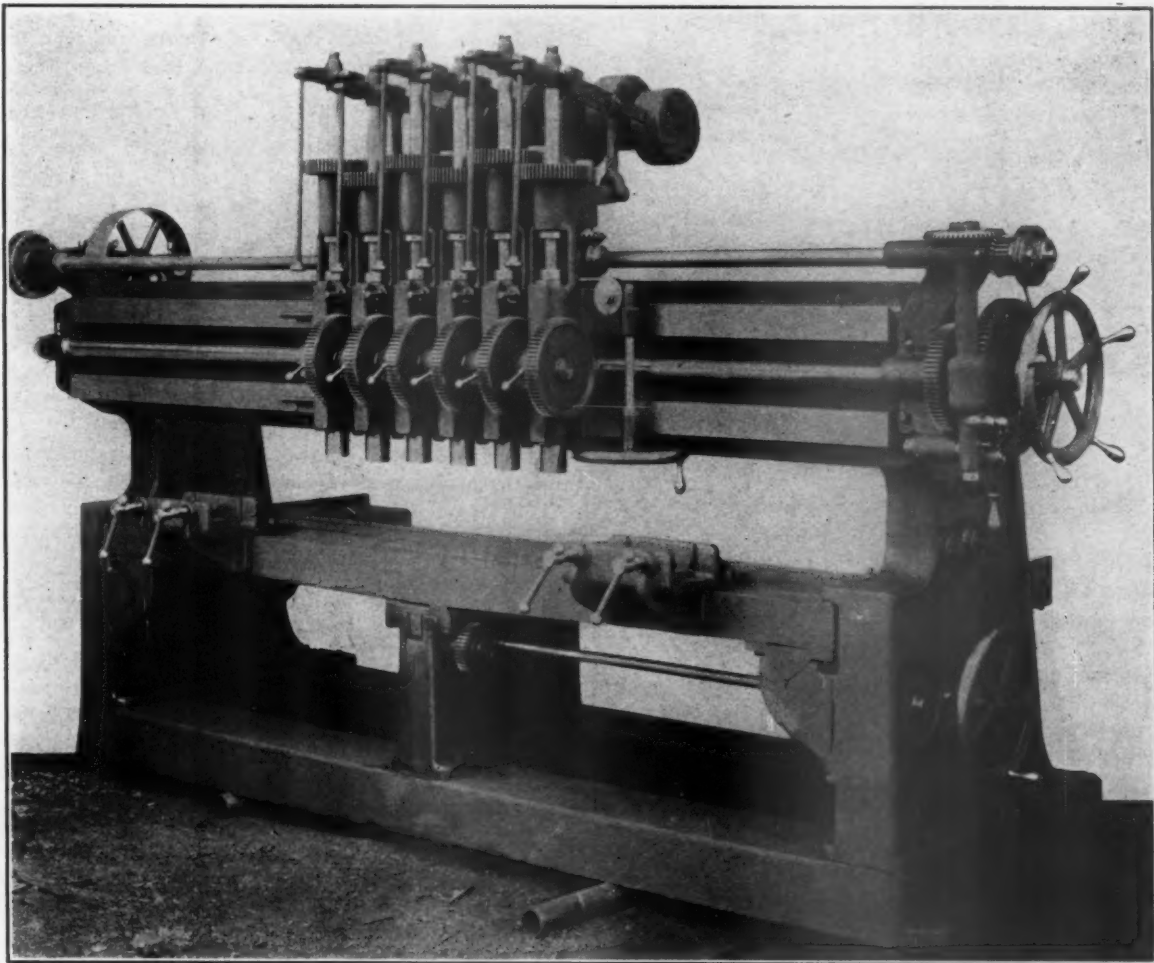
20-INCH UNIVERSAL MONITOR LATHE.

The universal monitor lathe, illustrated herewith, is designed for general brass turning and similar work of special and heavy character, and with the object of economically performing manufacturing operations without special tools. The turret carriage is provided with an automatic feed, similar to that of an ordinary engine lathe, and the four coarsest feeds are 8, 11½, 14 and 18 per in., conforming with the standard pipe threads. This arrangement not only avoids the stripping of the threads in large tapping, but inside and outside straight and taper threads may be cut by a turret tool without a tap or die. There are 12 changes of feed in all, the other eight being multiples by 3 and 6 of the four coarse feeds. Four changes of feed can be made instantly by a handle, located below the headstock, and the reverse is made by a knob in front of the apron.

hand threads may be cut without changing the leader. The headstock is friction back-gear, and has a four-step cone pulley with an extra large belt contact. The spindle has a 1-13/16-in. hole through it, and a wire feed can be easily applied. The cabinet support under the head is provided with tool shelves, and the tail leg is attached in a hinge manner to form a three-point support. This machine weighs about 2,900 lbs., and is made by the Drees Machine Tool Company, Cincinnati, O.

MUD RING DRILL.

Although the mud ring drill, shown in the accompanying illustration was specially designed for that purpose, it is equally well adapted for all operations of multiple drill work. The heads instead of sliding on an auxiliary rail, as in the ordinary construction, adjust directly on the main rail, which



BICKFORD MUD RING DRILL.

Interposed between the lower and upper part of the turret carriage is a double dove-tailed plate, to the lower side of which is swiveled-connected, a shoe which slides on the bar of the taper attachment shown below the bed. The frame of this attachment slides between the V's of the bed and the bolt clamping, the guiding bar also holds it in any position longitudinally. The whole attachment can readily be removed when not in use. The upper part of the intermediate dovetail plate has a screw with a ball crank handle for cross feeding by hand, and screw clamping stops are provided for setting the turret holes in line with the spindle.

The turret carrying slide is provided with a pilot wheel for rapid longitudinal movement and a screw for finer adjusting. The turret revolves on a stem with adjustment for wear, and the locking pin withdraws at the return movement of the top slide, making it semi-automatic. The machine is equipped with the ordinary chasing bar and the follower holder is yielding for taper work. Right and left

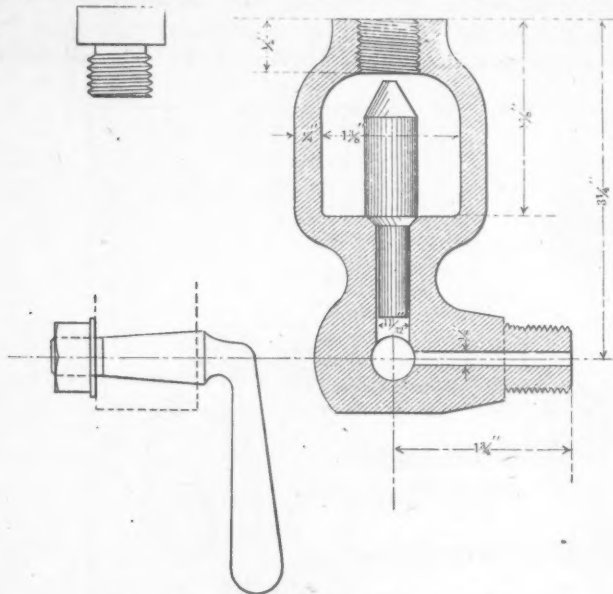
enables them to be spread to any desired center distance each head being provided with an independent adjustment. For mud rings or similar work where it is desirable that the heads should adjust collectively the heads are clamped together by means of two quick-acting nuts, which fix the center distance between spindles at 7½, 8, 8½ or 9 ins. as may be required. A dial on the worm-wheel at the upper corner of the right hand head shows the distance through which the heads are moved to the right and left.

The speed and feed changes are obtained by means of change gears, which are held in position by spring plungers, thus enabling the operator to change quickly from one speed or feed to another without lessening the available power of the machine. A dial on the large worm-wheel at the right shows where to set the dog to trip the feed at any desired depth. The spindles are 1 13/16 ins. in diameter, have a vertical movement of 12 ins. and work to a maximum center distance of 26¼ ins. The table has a transverse movement

of 24 ins. and receives between housings with a 12 ft. rail, work up to 10 ft. 6 ins. Driven by a constant speed pulley the power is never less than that obtainable from a 5-in. double belt, running at 1,696 ft. per minute. The net weight of this machine, which is made by the Bickford Drill & Tool Company, Cincinnati, Ohio, is 17,500 lbs.

LUBRICATOR FOR LOCOMOTIVE AIR PUMPS.

Considerable trouble has been experienced due to wear of the air piston packing rings and the air cylinders of locomotive air pumps, because of insufficient lubrication. The accompanying drawing shows a lubricator which has been in use on the Northern Pacific Railway for the past three years



LUBRICATOR FOR LOCOMOTIVE AIR PUMPS.

with excellent results. A hole is tapped for it midway between the two ends of the air cylinder. The plunger has $1/32$ in. lift, and as air is compressed the valve is raised off its seat, and when the air is drawn into cylinder the valve is seated, and thus at each stroke of the pump a small amount of oil is fed to the cylinder. The body of the cup is of cast iron, while the plunger and cap screw are of steel. The lubricator holds one cu. in. of oil, enough for a round trip over a division of 150 miles. The plug valve in the passage between the oil reservoir and the pump, is a recent improvement, and by its use it is unnecessary to stop the pump working whilst the lubricator is being filled. This lubricator was designed and patented by Mr. A. W. Wheatley, now superintendent of shops at Moline, of the Rock Island System. By its adoption in a mountainous country, pumps have run as long as ten months on one set of air cylinder packing rings, whereas, prior to its use the packing rings never gave more than one month's service.

1906 M. C. B. AND M. M. CONVENTIONS.

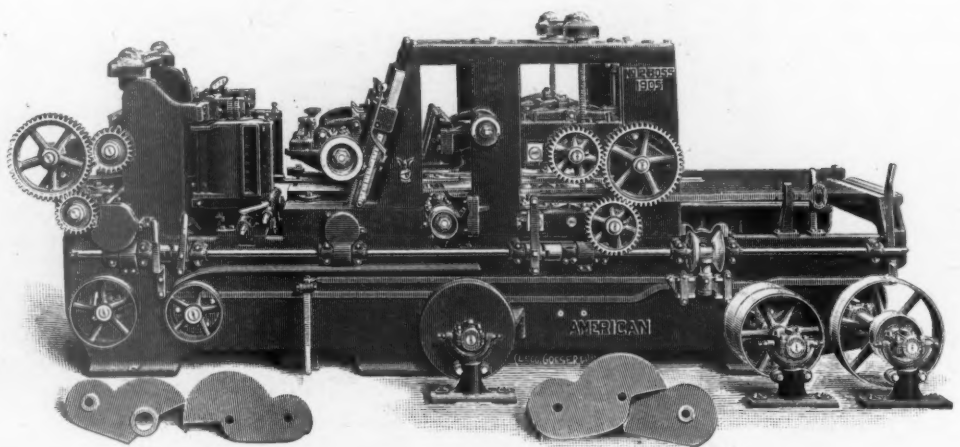
At a meeting of the joint executive committees of the Master Car Builders' and American Railway Master Mechanics' Associations at the Hotel Manhattan, New York City, December 11, it was decided to hold the next annual conventions of

these Associations at Atlantic City, N. J. The Master Car Builders' Association will meet June 13 to 15 inclusive, and the American Railway Master Mechanics' Association, June 18 to 20 inclusive. A number of hotels, members of an association in Atlantic City, agreed to reserve in all 2,040 rooms, with 825 private bath rooms. The meetings will be held on the Iron Pier, which is but a few minutes' walk from most of the hotels. The exhibits will be placed on the east side of the Iron Pier. Applications for space should be made to L. B. Sherman, Secretary of the Supplymen's Association, Old Colony Building, Chicago, Ill.

AMERICAN BOSS TIMBER SIZER.

The engravings show the front view of the new American Boss timber sizer with six rolls and the rear view of a similar machine with eight rolls. These machines are very heavy and powerful, but the construction is simple and they are very easily handled. All parts which require adjustment are arranged so that they may be quickly and conveniently adjusted with a minimum amount of exertion on the part of the operator. These machines are adapted for a very wide range of work. The six roll machines are made in sizes to work 20 or 30 ins. wide by 12 or 14 ins. thick, while the eight roll machines work 20 or 30 by 16, 18 or 20 ins. thick. The sides of the frame are heavily ribbed and the cross girts are planed to a seat and firmly bolted. The construction throughout is very substantial and rigid.

The bottom cylinder cuts first, and it can be quickly drawn out for changing or sharpening the knives. The front lower cylinder bar, together with the lower feed rolls, is so arranged that by the use of a hand wheel on the side of the machine the cut of the under head may be changed as desired, while the machine is running, without altering the finished thickness of the material or disturbing the cutter head, and any desired amount of stock can be removed up to $3/4$ of an in. The top and bottom cylinders are made of hammered crucible steel forgings, slotted on four sides, and have



AMERICAN BOSS TIMBER SIZER, SIX ROLLS, FRONT VIEW.

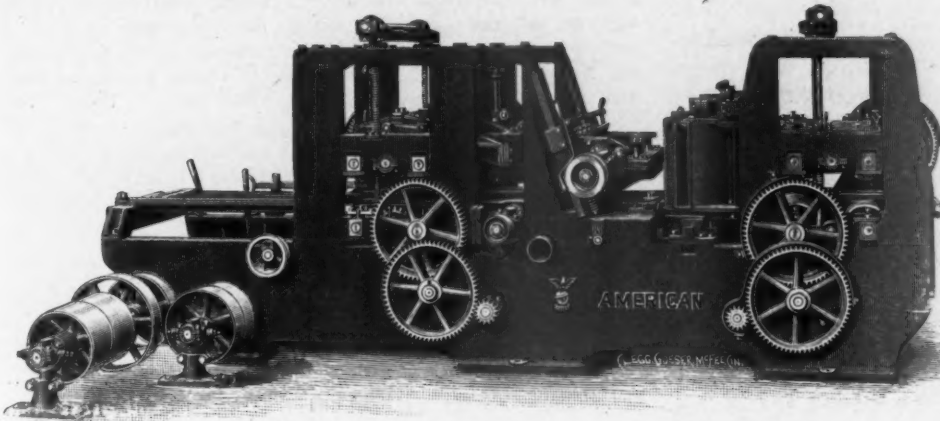
extended lip chip breakers. The journals are of large diameter and run in long self-oiling boxes. The feed is very powerful, consisting of 10-in. rolls, geared at both ends, well geared back to the two pinions that divide the labor. On the 30-in. machine the first two top rolls are divided, while on the 20-in. machine all rolls are solid, and all top rolls are independently weighted and rise and fall parallel to the bottom rolls.

The side spindles and jointer heads are of hammered crucible steel. The jointer heads can be quickly removed by the removal of the top boxes, when matcher or other style of heads may be substituted. The cylinder and side spindle boxes are all large, contain self-oiling devices, and each pair is heavily yoked together to insure their perfect alignment. The top cylinder yoke is supported on substantial uprights, and, when set to desired thickness may be firmly clamped in

position by means of a lever at the front side of the machine. The lower cylinder yoke is held in planed ways, and has independent adjustment and is firmly clamped when back in position. The side yokes or boxes are supported on three

NEW UNIVERSAL MILLING MACHINE.

The Becker-Brainard universal milling machine, illustrated herewith, embodies several important improvements, among them the positive gear feed drive and the change feed mechanism, by which any one of 20 changes of feed can be obtained without stopping the machine; also a new clutch mechanism in connection with the hand wheels, a box type of knee and a telescopic elevating screw. The spindle is made of hammered crucible steel, has a $\frac{3}{4}$ -in. hole through its entire length and runs in self-centering bronze boxes, arranged to compensate for wear. It has a slot across the end to engage a clutch collar on the arbor and is threaded to take a chuck, a threaded collar covering the screw when not in

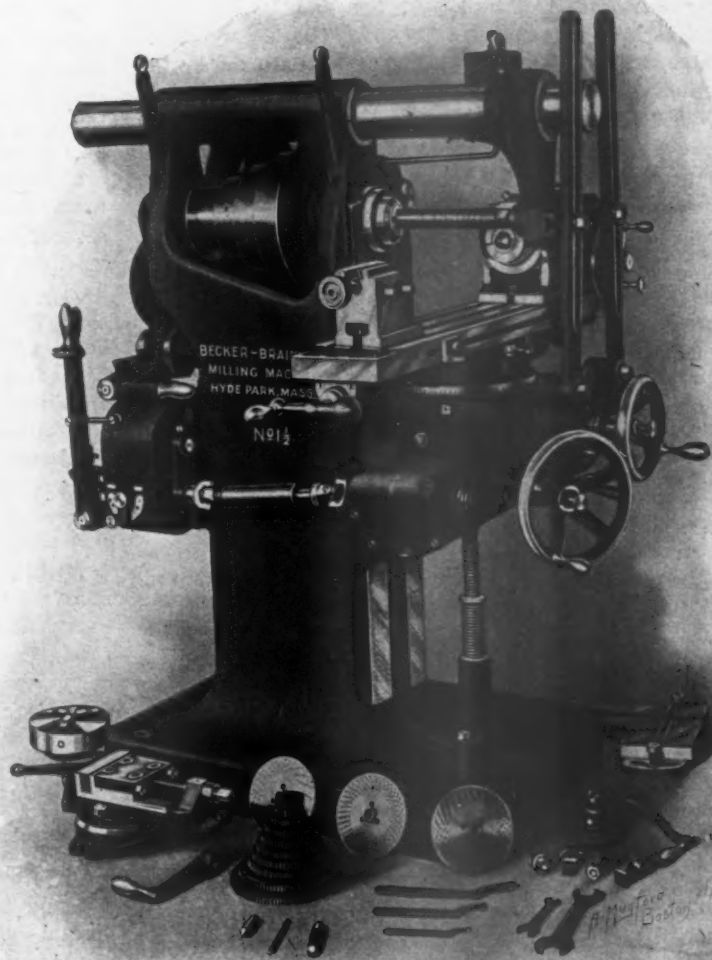


AMERICAN BOSS TIMBER SIZER, EIGHT ROLLS, REAR VIEW.

heavy cross bars and by means of attached levers which operate wedges, these boxes are clamped firmly in position. Pressure bars for the lower cylinder can be adjusted to allow the knife to extend $\frac{3}{4}$ in. beyond the lip of the cylinder. The pressure bars over the lower cylinder are hung on separate yokes and rise and fall vertically in pockets. The pressure is obtained by weights. They are carried in the same frame that carries the top cylinder and chip breakers; and, therefore, do not have to be adjusted independently. The chip breaker for the top cylinder is in four sections, and so constructed as to allow of an independent yield of $1\frac{3}{4}$ in. on each section, and the whole chip breaker will yield further by swinging up on the arms. The chip breakers for the side heads are made up of narrow sections, interchangeable and adjustable, held in a swinging frame in the shape of a hood. This is pivoted, and when the chip breaker weight is unhooked, may be swung clear of the head to admit of free access to the cutters. Exhaust pipe can be readily attached. The frame or slide holding the lower cylinder yoke is so formed as to make a complete hood for this head, to which pipe connections can be made.

The top feed rolls and top cylinder can be almost instantly adjusted by the use of a power hoist, which can be operated from the operator's position at the end or side of the machine. It is very effective, being belted from the main countershaft, and is available whether the feed is on or off. The side rods that convey the power to the screws which raise and lower the upper rolls are in three sections, coupled by clutches, which may be adjusted independently so that the rolls before the cut may be raised and lowered by power independently, to take care of stock of unusual variations in thickness, or the rolls and the top head may be raised without disturbing the position of the rear rolls, or the outfeeding rolls may be raised when a light cut is being taken to avoid marring the lumber.

These machines are made by the American Wood Working Machinery Company, and require about 40 h.p. for driving.



BECKER-BRAINARD UNIVERSAL MILLING MACHINE.

use. The spindle is connected with the change feed mechanism by three spur gears and is back-geared in 5 to 1 ratio. The gears are protected by guards.

Sixteen spindle speeds ranging from 15 to 355 r.p.m. are provided for. The change feed mechanism is conveniently located on the back of the column and any one of 20 feeds, ranging from 0.002 to 0.125 ins. per revolution of the spindle, may instantly be obtained while the machine is running, by moving the vertical lever at the side of the box. The

table has a working surface of $37\frac{1}{4}$ by 7 ins. and has an automatic longitudinal (24 ins.), and a cross feed (8 ins.) in either direction. The table is centrally driven and feeds freely at any angle up to 45 degs. either side of the center line. The feed may be reversed from the front of the machine.

The hand wheels are provided with a clutch arrangement enclosed in a hub. One of these wheels controls the vertical movement of the knee and the other the table cross feed. When either the knee or carriage have been set to the required position the clutch may instantly be disengaged by pressing the knob on the front of the hand wheel, thus preventing any accidental change from their fixed position, and, also, preventing them from revolving when the automatic feeds are thrown in. The dials for indicating the vertical, transverse and longitudinal movements of the platen are adjustable and graduated to read to thousandths of an inch, and may be set at any position with a set screw.

The arm is made of steel, has a horizontal adjustment and the arbor support may be removed so that any of the attachments can be placed in position without the necessity of removing the arm. The dividing head can be set at any angle from 10 degs. below the horizontal to 5 degs. beyond the perpendicular. It is arranged for plain and differential indexing of all numbers to 360. By means of 10 change gears nearly any spiral from 1.25 to 68.57 ins. may be cut. The knee has a vertical adjustment of 17 ins. The net weight of this machine, which is known as No. 1 $\frac{1}{2}$, and is made by the Becker-Brainard Milling Machine Company, of Hyde Park, Mass., is 2,500 lbs.

BOOKS.

Pocket-book of Mechanical Engineering. By Charles M. Sames. 168 pages, 38 illustrations. Published by Charles M. Sames, 448 Jersey Avenue, Jersey City, N. J., 1905. Bound in flexible leather. Price, \$1.50.

The author's aim has been to compact the greater part of the reference information usually required by mechanical engineers and students, into a volume which can be carried in a pocket without inconvenience, and he has been remarkably successful. The book measures 4 by 6 $\frac{1}{2}$ ins. and is only about 5/16 in. thick. It is replete with tables, data, formulas, theory and examples conveniently and compactly arranged, and includes the very latest obtainable data. The main sub-divisions of the book are as follows: mathematics; chemical data, materials; the strength of materials, structures and machine parts; energy and the transmission of power; heat and the steam engine; hydraulics and hydraulic machinery; shop data and electrotechnics. A good index has been provided and in addition to this the subject matter is so classified that any subject may easily be referred to.

Poor's Manual, 1905. Thirty-eighth annual number. Published by Poor's Railroad Manual Company, 68 William Street, New York. Price, \$10.00.

This volume, issued in November, contains more than 1,600 pages devoted to detailed statements of the operations and conditions of every railroad company, steam and electric, in the United States and Canada and the leading railroads in Mexico. Also similar information concerning miscellaneous industrial corporations and a department devoted to statements showing the finances and resources of the United States, the several states, and the chief counties, cities and towns in this country, together with detailed descriptions of the funded debts of each. In addition it contains twenty-four colored plate State and group maps and 48 maps of leading railroads. The statistics show that in the United States at the close of 1904 there were 212,349 miles of railroad in operation, or an increase of 5,414 miles over the preceding year. The number of locomotives was 48,658, or 4,129 more than at the end of the preceding year, while the number of revenue earning cars was 1,770,884, or an increase of 41,481 in one year.

Gas, Gasoline and Oil Engines, including Gas Producer Plants. By Gardner D. Hiscox. Fifteenth edition; 450 pages; 351 illustrations. Published by the Norman W. Henley Publishing Company, 132 Nassau Street, New York City, 1906. Price, \$2.50 net.

The many recent improvements in the design of internal combustion engines, and the rapid development of the producer gas

industry have been such that it was necessary to entirely revise and rewrite the previous edition of this work, in order to bring it up-to-date, and this volume is practically a new book from cover to cover. It considers gas, gasoline, kerosene and crude petroleum oil engines and also producer gas plants. It fully describes and illustrates the theory, design, construction and management of the explosive motor for stationary, marine and vehicle motor power. An important addition is the regulations of the National Board of Underwriters in regard to the installation and operation of gas producers. The list of United States patents of explosive motors has been brought up-to-date, and a list of the manufacturers of these engines in the United States and Canada has been added. This volume forms a very valuable and important contribution, and should be in the hands of all those who are interested in this subject.

H. H. VAUGHAN.

Mr. H. H. Vaughan, superintendent of motive power of the Canadian Pacific Railway has been advanced with the title of assistant to the vice-president of that road. It is understood that this new office constitutes jurisdiction over motive power, rolling stock, stores, fuel and all electrical and mechanical matters. This is a distinct recognition of the importance of placing motive power and rolling stock matters in the hands of an executive who is not a department official.

Mr. Vaughan was born in England, graduated from Kings College, London, served an apprenticeship at the works of Naysmith, Wilson & Company, at Patricroft, Eng., and after that worked for a short time as a machinist at the Gorton Shops of the Manchester, Sheffield and Lincolnshire Railway, and at the Nine Elms works of the London and South Western Railway. In 1891 he came to the United States and entered the shops of the Great Northern as machinist. He served as draftsman from September, 1891, to May, 1894, when he was made assistant engineer of tests. In May, 1895, he became mechanical engineer, and while in this position developed marked ability in designing a number of important devices, among which is the present engineer's valve of the New York Air Brake Company. In February, 1898, he was appointed mechanical engineer of the Philadelphia & Reading Railroad at Reading, Pa., and two years later was placed in charge of the management of shops and mechanical engineering department of the Q. & C. Company in Chicago, where he had valuable manufacturing and commercial experience. In March, 1902, he was called to the Lake Shore & Michigan Southern Railroad as assistant superintendent of motive power, and in February, 1904, was appointed superintendent of motive power of the Canadian Pacific. On this road Mr. Vaughan has had the difficult task of organizing the operations of the very large new railroad shops, which of itself is a sufficient undertaking for the short time he has been there. This, however, is only a part of the record which he has made in the short time he has been at Montreal, which has now placed him in a leading position in the motive power world, and one in which he has a most promising opportunity to show the real importance and the great possibilities for improvement in motive power methods. Mr. Vaughan is a young man for his present responsibilities, and it is important to note that he came to this country fourteen years ago a perfect stranger and began his services as a machinist.

The action of the Canadian Pacific in making this appointment is significant of the appreciation of the magnitude of the motive power problem and its possibilities, which is an exceedingly hopeful sign of a radical change of opinion, which should lead to a revolution in the methods of handling the locomotive on railroads. The American motive power matters will never be handled as they should be until the highest officials realize the importance of placing the responsibilities in the hands of an executive and not a department officer.

We congratulate the Canadian Pacific upon their choice, and also Mr. Vaughan upon his well-merited promotion, and extend our best wishes for his future success.

PERSONALS.

Mr. F. M. Fryburg has been appointed master mechanic of the Montana Central at Great Falls, Mont., succeeding Mr. C. M. Prescott, resigned.

Mr. Frank Zink has been appointed acting superintendent of motive power of the Santa Fe Central at Estancia, N. Mex., to succeed Mr. G. H. Shone.

Mr. George Tilton has been appointed superintendent of shops of the Mexican Central at Aguascalientes, Mex., to succeed Mr. H. V. Ridgeway, resigned.

Mr. W. J. Knox, chief draftsman of the Buffalo, Rochester & Pittsburg Railway, at DuBois, Pa., has been appointed mechanical engineer of that road.

Mr. A. B. Ford, traveling engineer of the Great Northern at Great Falls, Mont., has been appointed master mechanic at Minot, N. D., succeeding Mr. C. T. Walters.

Mr. George B. Longstreth, heretofore master mechanic of the Tennessee Central at Nashville, Tenn., has been appointed master mechanic of the Nashville Terminal Company.

Mr. C. T. Walters, master mechanic of the Great Northern at Minot, N. D., has been appointed master mechanic at Havre, Mont., succeeding Mr. F. M. Fryburg, resigned.

Mr. H. P. Durham has been appointed superintendent of motive power and machinery of the Tehuantepec National, at Rincon Antonio, Mexico, succeeding Mr. Louis Greaven.

Mr. W. W. Lowell, master mechanic of the Chicago, Burlington & Quincy at Brookfield, Mo., has been transferred to St. Joseph, Mo., to succeed Mr. Jacob Kastlin, resigned.

Mr. W. C. Ennis, master mechanic of the Delaware & Hudson at Oneonta, N. Y., has been appointed superintendent of car shops and repair work, with headquarters at Carbondale, Pa.

Mr. G. S. Edmonds, mechanical engineer of the Delaware & Hudson, has been appointed master mechanic of the Susquehanna & Pennsylvania division, with office at Oneonta, N. Y.

Mr. L. R. Johnson has been appointed assistant superintendent of motive power of the Canadian Pacific in charge of the Angus shops, and Mr. J. B. Elliott has been appointed general master mechanic of the lines east of Fort William.

Mr. C. S. Bricker has been appointed master mechanic of the Sheridan Division of the Burlington lines west of the Missouri River, with headquarters at Sheridan, Wyo., vice Mr. C. J. Saberhagen, resigned.

Mr. F. E. Kennedy has been appointed master mechanic of the McCook division of the Burlington Lines West of the Missouri, with headquarters at McCook, Neb., to succeed Mr. R. B. Archibald, resigned.

Mr. J. H. Bannerman, formerly superintendent of motive power of the Tennessee Central, has accepted a position with the W. J. Oliver Manufacturing Company of Knoxville, Tenn., as mechanical superintendent.

Mr. S. B. Gorbitt has resigned from the position of mechanical engineer on the Colorado Midland Railway, at Colorado City, to accept the position of mechanical superintendent of the Portland Cement Company, at Portland, Colo.

Mr. H. C. Woolbridge, heretofore general foreman of the Delaware, Lackawanna & Western, at Elmira, N. Y., has been appointed master mechanic of the Buffalo and Rochester divisions of the Buffalo, Rochester & Pittsburg, with office at East Salamanca, N. Y.

Mr. William Donald has been appointed master mechanic of the Rio Grande Western at Salt Lake City, Utah, to succeed Mr. John Hickey, who has resigned owing to ill health.

The position of assistant superintendent of motive power on the Burlington lines west of the Missouri River has been abolished, and Mr. E. W. Flitt has been appointed master mechanic of the Alliance and Sterling divisions, with headquarters at Alliance, Neb., vice Mr. F. J. Kraemer, assigned to other duties.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER

LOCOMOTIVE BLOW-OFF VALVES.—The Lunkenheimer Company, Cincinnati, O., are sending out a circular which is devoted to their locomotive blow-off valves.

STEEL CRANE MOTORS.—Bulletin No. 32 from the Northern Electrical & Manufacturing Company, Madison, Wis., considers in detail the construction of the Northern steel crane motors and their application to cranes.

PNEUMATIC APPLIANCES.—Special circular No. 55 from the Chicago Pneumatic Tool Company, Fisher Building, Chicago, is devoted entirely to a description of pneumatic appliances for foundry and concrete block work.

COUPLING BOLT FORCER.—The Watson-Stillman Company, 46 Dey street, New York City, have sent out sheets Nos. 325, 326 and 329, which illustrate and describe the different varieties of this tool, which they manufacture.

SINGLE PHASE RAILWAY SYSTEMS.—Circular No. 1,127 from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is entirely devoted to control apparatus, trolleys and line construction for single phase railway systems.

VAPOR SYSTEM OF CAR HEATING.—Special circular No. 4 from the Chicago Car Heating Company, Railway Exchange, Chicago, describes the vapor system for car heating and pointedly calls attention to its advantages over other systems. Two large colored plates are introduced, which clearly show its construction, operation and advantages.

TRACK DRILLS AND DRILL BITS.—The Buda Foundry & Manufacturing Company, Railway Exchange, Chicago, are sending out a catalog which is devoted to a description of the various improvements which have been made in track drills and attachments. Considerable space is devoted to the Rich flat drill bit, which is made of high-speed steel.

MOTORS FOR HOISTING SERVICE.—Leaflet No. 148 from the Northern Electrical Manufacturing Company, Madison, Wis., shows several applications of the Northern box type motor to different types of hoists. These motors are specially designed for this service; they are dust and weather proof and have exceptionally strong shafts and liberal bearings.

ELECTRICAL APPARATUS.—The following bulletins have been received from the General Electric Company, Schenectady, N. Y.: No. 4,423, alternating current (1,150 and 2,300 volt) switchboard panels; No. 4,425, 4,500 volt oil break switches; No. 4,426, C1-B slow and moderate speed belt-driven generators; No. 4,427, Type MC governor for electrically driven air compressors.

THE PENNSYLVANIA SPECIAL.—The Pennsylvania Special, a two-step march by Bandmaster F. N. Innes, is being distributed in the interest of their 18-hour train between Chicago and New York. The music is dedicated to Samuel Moody, general passenger agent, and will be sent upon receipt of four cents, to cover postage, by the Pennsylvania Lines' Advertising Bureau, 702 Union Station, Pittsburg, Pa.

PNEUMATIC TOOLS AND APPLIANCES.—A handsome 6 by 9, 192 page general catalog has been received from the Chicago Pneumatic Tool Company, Chicago. It covers their entire line of pneumatic tools and appliances, together with a complete price list of the repair parts used on all tools in general use, including the "Boyer" and "Keller" products. This catalogue is ready for distribution and copies will be supplied, to those who are interested, upon application to the Chicago office.

BRAKE BEAMS.—A handsome catalog has been received from the Buffalo Brake Beam Company, Buffalo, N. Y. It is devoted to an illustrated description of the various beams, fulcrums, wheel guards, chain clips and safety hangers made by them.

STEAM ENGINE INDICATORS.—A folder from the American Steam Gauge & Valve Manufacturing Company, Boston, Mass., considers the several important advantages of the American-Thompson improved indicator with the new detent motion and the American ideal reducing wheel.

HOISTING AND CONVEYING APPLIANCES.—A handsome 200 page 12 by 9 catalog has been received from the Brown Hoisting Machinery Company, Cleveland, O. It is devoted to their hoisting and conveying appliances and contains a large number of full page half-tone views, showing various applications of apparatus designed and erected by them. These include cranes and conveying apparatus of all kinds. Among the applications of special interest to railroads are the bridge tramways for unloading coal and ore, the "Brownhoist," "Fast Plants," car-dumping machines, locomotive coaling stations and locomotive cranes.

WOOD WORKING MACHINERY.—A very handsome catalog has been received from the American Wood Working Machinery Company, which shows a complete line of machinery for general use in planing mills, sash, door and blind, box, furniture, cabinet, car, agricultural implement, pattern and general wood-working shops. The illustrations of the various machines are large and the details are very clearly shown. The descriptions of the tools are complete and are so arranged that the information concerning any part can quickly be found. This is one of the best arranged and handsomest catalogs which we have ever received. It contains 320 pages, 9 by 12, and is cloth bound. The cover is tan colored and the lettering is done in black and gold.

MOTOR CARS FOR RAILROAD WORK.—Catalog No. 101A from Fairbanks, Morse & Company, Chicago, Ill., describes the various types of Sheffield gasoline inspection and section motor cars and considers the advantages and savings due to their use. We are informed that Mr. George H. Webb, chief engineer of the Michigan Central Railroad, made an inspection trip over that system on a No. 16 car last summer. The distance traveled was 4,347 miles and the total amount of gasoline used was 231 gallons, or an average of 19.7 miles per gallon. The total cost per mile, including lubricator oil, battery cells and everything excepting the wages of the man in charge, was nine-tenths of a cent. The car demonstrated its ability to attain a high rate of speed and maintain it on long runs.

COLE 4-CYLINDER BALANCED COMPOUND LOCOMOTIVE.—A very attractive thirty-six page pamphlet, with this title, has just been issued by the American Locomotive Company. The reasons for recommending this form of construction to meet American conditions are outlined, and locomotives of this type which have been applied to the New York Central, Erie and Pennsylvania Railroads are illustrated and described. A brief statement of the performance of the New York Central locomotive No. 3,000 on the testing plant at St. Louis is given, and line drawings showing elevations and sections of this locomotive and the construction of the frames, cylinders, crank axles and valves are presented. Line drawings are also introduced showing the application of the 4-cylinder balanced compounding to different types of freight and passenger locomotives. The pamphlet concludes with a number of comments from the technical press concerning this type of locomotive.

STURTEVANT PUBLICATIONS.—The B. F. Sturtevant Company, Boston, Mass., will hereafter issue most of its publications periodically under the title "Sturtevant Engineering Series." Each individual bulletin will treat of some particular product or its application. The series will also include reprints of pertinent articles or technical papers. All publications will be issued in uniform style and size suitable for binding consecutively or in allied groups. Bulletin No. 125, the first of this series, has just been published. It describes in detail the line of automatic vertical engines manufactured by the Sturtevant Company. These range from 5 by 5 ins. to 12 by 10 ins., are entirely enclosed and all bearings are provided with positive forced lubrication under 15 lbs. pressure. These engines, primarily designed to meet the exacting requirements of dynamo driving, are capable of continuous operation without skilled attention and represent the highest standard of material, workmanship and efficiency.

HORIZONTAL SLAB MILLING MACHINES.—Catalog No. 42 from the Newton Machine Tool Works, Philadelphia, Pa., considers their latest design of planer type milling machines; notable among these is the type with the auxiliary verticle spindle, which was described on page 381 of our October issue. An interesting illustration shows the method used in one of the large railroad repair shops for milling locomotive driving box shoes, and another illustration shows one of the latest improved machines milling the flutes in locomotive side rods.

NOTES.

FALLS HOLLOW STAYBOLT COMPANY.—This company of Cuyahoga Falls, O., announce that Falls Hollow iron has been specified for a number of locomotives recently ordered from the Baldwin Locomotive Works by the Seoul Fusan Railroad of Japan.

THE FARLOW DRAFT GEAR COMPANY.—This company, of Chicago, announces that they have recently received orders for 1,200 Farlow draft gears from the Great Northern Railway, 400 of them are to be used on Rodgers ballast cars and 800 on 50-ton steel ore cars.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.—During the month of October this company, whose plant covers 47 acres at West Pittsburg, shipped seventeen million pounds of electrical apparatus, consisting of over 5,000 individual consignments, and in addition to this sent out a large number of local freight and express orders.

THE CRANE COMPANY.—Mr. Charles A. Olson, who for several years has been superintendent of the flanged fitting department, has been promoted to the newly created position of general superintendent of the company. Mr. Olson was formerly superintendent of the St. Petersburg, Russia, plant of the Societe Anonyme Westinghouse.

T. H. SYMINGTON COMPANY.—Mr. David R. McKee, Jr., has accepted a position in the sales organization of this company. He was formerly connected with the Western Steel Car & Foundry Company and with the engineering department of the Delaware, Lackawana & Western Railroad. His headquarters will be at the Chicago office in the Railway Exchange.

WM. B. SCAIFE & SONS COMPANY.—This company, of Pittsburg, Pa., state that they have received a contract from the Pittsburg Railways Company for a steel frame trestle and viaduct 455 ft. long, and varying from 30 to 101 ft. high with girder spans from 26 to 90 ft. This trestle is to be erected over Lowry's Run, near Emsworth, Pa. They have also received the contract for the construction and erection of a structural steel engine house 100 ft. by 50 ft. and 50 ft. high, with a crane run-way, for the Cherry Valley Iron Company at West Middlesex, Pa.

STORAGE BATTERY RECEPTACLE.—The Westinghouse Electric & Manufacturing Company have recently placed on the market a storage battery charging receptacle having many advantageous features, among the more important being a swivel attachment which conforms the receptacle to standard steam railway practice, and allows the car or vehicle to start and pull out the cables without danger of breaking them or the contacts. The apparatus is adapted to both railway and automobile service, and has been adopted by the Pennsylvania Railroad for charging the batteries on their cars.

B. F. STURTEVANT COMPANY.—This company of Boston, Mass., announces that the 30-stall roundhouse of the Intercolonial Railway at Truro, N. S., is being equipped by them with a complete heating and ventilating system, especially designed for the rapid thawing out of engines. An induced draft apparatus is also being furnished for the boiler plant. They also announce that the new machine and smith shops of the Pennsylvania Railroad Company at Hollidaysburg, Pa., are to be heated and ventilated by their apparatus. Also that the car paint shop of the Pressed Steel Car Company, at McKees Rocks, Pa., containing nearly 4,000,000 cu. ft. of space and a similar shop at Allegheny, Pa., for the same company, containing 2,500,000 cu. ft. is to be heated and ventilated with their equipment.

WANTED.—"Mechanical Draftsman who understands machine design and repairs and has had practical shop experience. Prefer one who has worked under a shop engineer. State experience and salary expected. Address L. N. G., care of this paper."